

Development of Standard Cooking Fires for Evaluation of Range Top Fire Prevention Technologies

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Range Top Cooking Fires

- A leading cause of U.S. fire loss
 - ◆ 58% of all reported home cooking fires (91,000 fires per year);
 - ◆ 87% of home cooking fire deaths (331 annual deaths); and,
 - ◆ 76% of home cooking fire injuries (3,730 civilian injuries).
- Unattended equipment a factor in 1/3 of all home cooking fires.
- Attempts to fight fires a factor in 3/5 of injuries.
- Automatic prevention of range top fires is key.



Sponsors and Participants

- National Fire Protection Research Foundation
- National Institute of Standards and Technology
- Consumer Product Safety Commission
- State Farm Insurance
- Association of Home Appliance Manufacturers
- Underwriters Laboratory



Objectives

- Develop standard fire tests to evaluate performance of prevention technologies
 - ◆ Representative of cooking
 - ◆ Reproducible flaming ignition
 - ◆ Detectable pre-ignition parameters
- Develop criteria for evaluation of prevention technologies



Scope

- Develop test for evaluation of ***PREVENTION*** technologies only
 - ◆ No warning or suppression devices
 - ◆ Automatically prevent flaming ignition
- Ignition scenario
 - ◆ Combustible cooking materials in pan
 - ◆ No spills, adjacent combustibles, etc.
- Electric open coil range tops only



Functional Premise

- Prior to flaming ignition, detectable indicators can be measured by sensors
 - ◆ Pan/Burner/Food temperatures
 - ◆ Smoke and gas emissions
- System automatically controls range
 - ◆ Prevent ignition
 - ◆ Minimal impact on cooking operations



Fire Test Development

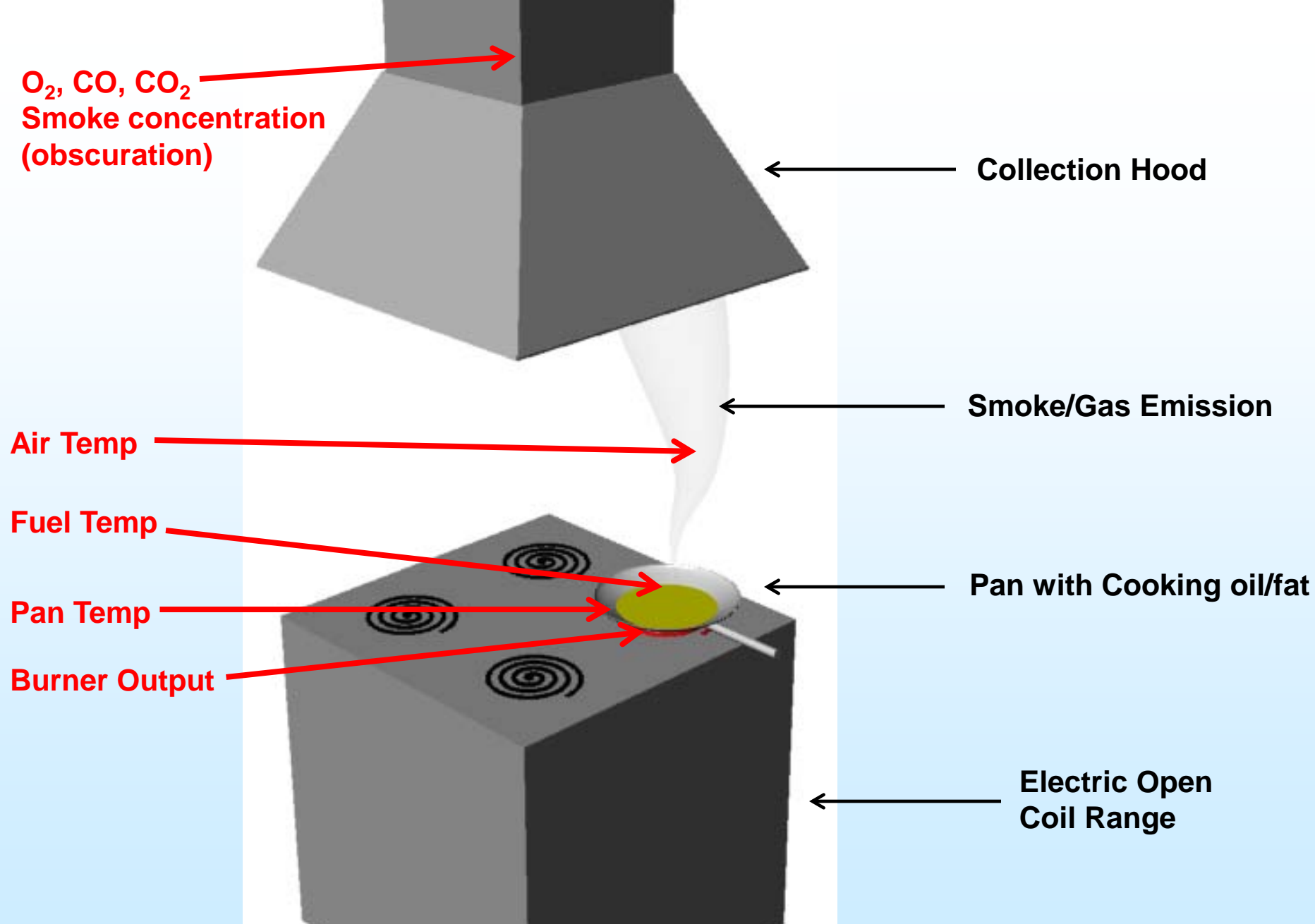
- Representative Cooking Scenarios
 - ◆ Only combustible fats and oils
 - ◆ Soybean (vegetable), corn, canola, and peanut oils
 - ◆ Beef tallow and pork lard
- Pans
 - ◆ Aluminum
 - ◆ Varying thicknesses and diameters
- Ranges
 - ◆ Electric coil
 - ◆ Varying power outputs and surface areas



Fire Test Development

- Characterize Pre-ignition Parameters
 - ◆ Surface/fuel/air temperatures
 - ◆ Smoke
 - ◆ O₂, CO, CO₂ gas emissions
- Standardized test parameters
 - ◆ Establish a valid test
 - ◆ Assess reproducibility
 - ◆ Independent of mitigation system





Standardized Fire Test Development



Fire Test - Ranges

- Two commercially available ranges



2600 W Max Power Output
6 coil burner surface



2100 W Max Power Output
4 coil burner surface



Fire Test - Pans

- Aluminum Pans
 - ◆ 70% of consumer products
 - ◆ Single material construction
 - No coatings, claddings
 - Repeatable and reproducible
 - ◆ Highest heat transfer – Ignition potential
- Investigated variables include:
 - ◆ Pan thicknesses
 - 5–10 gauge
 - Impact heat transfer
 - Ignition times/occurrence
 - ◆ Pan diameter
 - 7–14 inches
 - Ratio to burner diameter



Fire Test – Combustible Fats and Oils

- Oils selected based on total consumption and use for frying
 - ◆ Soybean oil (vegetable oil)
 - ◆ Canola oil
 - ◆ Corn oil
 - ◆ Peanut oil
- Animal fats
 - ◆ Beef tallow
 - ◆ Pork lard
 - ◆ Not commonly used for frying, but released by cooking solid foods



Fire Test – Combustible Fats and Oils

- Fats and oils purchased through commercial grade producer
 - ◆ High variability in consumer grade oils
 - Composition
 - Crop quality/time of year
 - Brand/manufacturer
- Characterized by Free Fatty Acid (FFA) content
 - ◆ Inversely proportional to auto-ignition temperature
 - ◆ Laboratory measurement of FFA
 - ◆ Characterize fuels for reproducing standardized testing



Fire Test – Additional Variables

- Used oil ignition
 - ◆ Reduced auto-ignition temperature
 - ◆ May be most hazardous scenario for evaluation of prevention devices
- Warped pan application
 - ◆ Flatness of pan bottom varied
 - ◆ Potential impact on detection device performance (contact sensor)
 - ◆ Potential impact on heating profile of test fuel (impacts valid test determination)



Fire Test Evaluation Criteria

- Determine fuels/pan/range settings that produce consistent flaming ignition and detectable parameters
 - ◆ Must ignite without prevention system
 - ◆ Lowest ignition temperature
 - ◆ Both slow and fast heating rates
- Measured pre-ignition parameters
 - ◆ Pan/fuel/air temperatures
 - ◆ Smoke and gas emissions
 - ◆ Reproducible curves for standard testing



Prevention Technology – Performance Criteria

- Prevent Flaming Ignition
 - ◆ Absolute minimum performance
- Temperature based criteria
 - ◆ Limit fuel temperature below ignition with safety factor applied
 - ◆ Use fuel temperature regardless of detection principle
 - ◆ Minimum activation temperature indicator of potential cooking performance effect



Project Outcomes

- A well characterized and standardized test (or set of tests) to be used for evaluation of open electric coil range top fire prevention devices
- A set of criteria for comparative evaluation of prevention devices



Questions?

