D8 The Impact of Ventilation on Fire Patterns in Full-Scale Structures: Experiments, Analysis, and Education

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Learning Overview: The goals of this presentation are to: (1) develop a better understanding of the relationship to the availability of oxygen in a structure fire and how that impacts the fire damage; and (2) learn how to access the data and video results from the study via a freely available, interactive web portal.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by showing the report, the time histories of the data, and the videos from this study that provide foundational documentation for the understanding of ventilation-controlled fires and the resulting fire patterns. Lack of knowledge of post-flashover and ventilation-controlled fire damage by fire investigators has resulted in unwarranted prosecutions and incarcerations for arson. This study supports the understanding of separate and distinct fire patterns that are generated by ventilation-controlled burning conditions in a structure. In past criminal cases, fire investigators have misunderstood ventilation-generated patterns and incorrectly identified them as evidence of arson.

Residential fires tend to be ventilation limited. Understanding ventilation-limited fires can aid fire investigators in analyzing fire patterns and locating the area of origin. When and where the fire receives oxygen impacts the fire and subsequent fire patterns. With the support of the National Institute of Justice, a series of full-scale fire experiments were conducted to: (1) examine how differences in ventilation to full-scale structure fires result in changes to the fire damage and fire patterns within the structure; (2) measure the fire environment within the structures and compare the data with the fire damage in the structures; and (3) document the repeatability or lack thereof of the fire conditions and fire patterns within a structure based on the available ventilation. The experiments were planned with the assistance of a technical panel that included members of the American Academy of Forensic Sciences, Bureau of Alcohol Tobacco and Firearms, International Association of Arson Investigators, National Association of Fire Investigators, National Association of State Fire Marshals, National Institute of Standards and Technology (NIST), NIST Organization of Scientific Area Committees for Forensic Science, and the National Fire Protection Association.

The test structures included a 1,200 sq. ft. one-story ranch structure and a 3,200 sq. ft. two-story colonial structure. The colonial had an open floor plan with a two-story family room and open foyer. The test scenarios ranged from fires in the structures with no exterior ventilation to room fires with flow paths that connected the fires with remote intake and exhaust vents throughout the structures. Elevated fires originating in the kitchens were also examined.

The structures were photographed before and after each fire experiment. Instrumentation was installed to measure gas temperature, gas pressure, and gas movement within the structures. In addition, oxygen sensors were installed to determine when a sufficient level of oxygen was available for flaming combustion in a given area. Standard video and firefighting thermal imaging cameras were also installed inside the structures to capture information about the fire dynamics of the experiments. Video cameras were also positioned outside the structures to monitor the flow of smoke, flames, and air at the exterior vents.

The results from a series of full-scale house experiments examining the impact that changes in ventilation had on the fire patterns are available for reference and further study on the free UL Firefighter Safety Research Institute (FSRI) web portal, fireinvestigation.ulfirefightersafety.org.

This presentation will highlight key findings of the study using photos, data, videos, and fire flow graphics. The use of the fire investigation portal to access the report, data, videos, and free on-line training will also be demonstrated.

Fire Pattern, Ventilation-Limited Fire, Flashover

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