

# Computer modeling study reveals the lethal dynamics of a San Francisco house fire

February 2 2015, by Mark Bello

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A new computer-based fire-dynamics study by researchers at the National Institute of Standards and Technology (NIST) has helped to clarify the circumstances and violent fire behavior of a lethal 2011 blaze in a San Francisco hillside home. The fire in the multi-story, single-family dwelling claimed the lives of two firefighters.

The analysis, conducted using NIST's Fire Dynamics Simulator, underscores the importance of ascertaining how heat and gases are likely to flow in a burning building before mounting an attack.

Summarized in a report and a video (see box), the study concludes that the failure of basement windows near where the fire began transformed an interior stairwell into a "chimney for hot gases" that poured onto the first floor, where the downed firefighters were found. Air rushing in from the outside intensified the fire, creating a region of high pressure. The hot gases streamed up the stairwell at an estimated 20 miles per hour toward a door on the first floor, where the pressure was significantly lower.

Within two minutes after the first basement window failed, the temperature near the first-floor door had roughly doubled to more than 200 degrees Celsius (400 degrees Fahrenheit), according to the model. At a temperature of 260 degrees Celsius, risks to even properly equipped firefighters increase significantly after five minutes of exposure.

A National Institute for Occupational Safety and Health (NIOSH) report

on the San Francisco fire notes that a second crew of responders tried to enter the first floor through a garage door, but they were repelled by intense heat. Both of the firefighters already inside were discovered after fire suppression operations began in the basement. One, a lieutenant, was pronounced dead at a local medical center, and the other, a firefighter/paramedic, died two days later.

"Research by NIST, Underwriters Laboratories, and others has demonstrated that applying water from the exterior into the fire area of a structure (prior to the start of interior operations) can significantly improve the safety of firefighters by reducing the thermal hazard from the fire and reducing the potential for developing high velocity hot gas flows within the structure," the NIST fire protection engineers write in the study report.

The NIST study was requested by the San Francisco Fire Department and NIOSH. This analysis and others conducted with the agency's Fire Dynamics Simulator and its visualization software, Smokeview, yield insights into the development and the thermal conditions of [fire](#) that have resulted in line-of-duty deaths of firefighters. The objective of these studies is to improve the safety and effectiveness of [firefighters](#).

**More information:** K. J. Overholt, C. G. Weinschenk and D. Madrzykowski, "Simulation of a Fire in a Hillside Residential Structure—San Francisco," CA (NIST Technical Note 1856); November 2014. Available at: [dx.doi.org/10.6028/NIST.TN.1856](https://dx.doi.org/10.6028/NIST.TN.1856)

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