Title: Simulation of Radiological Containment Ventilation Performance during Fire Events in Facilities with Exhaust HEPA Filtration using the Fire and Smoke Simulator (FSSIM)

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Topics: Fire Modeling, Fire Hazard Analysis

Abstract:

Nuclear facilities use High Efficiency Particulate Air (HEPA) filtration, in combination with zone pressurization techniques to maintain radiologic containment. During a fire, the heat and smoke produced present challenges to these containment strategies. The Fire and Smoke Simulator (FSSIM) is an effective tool used to evaluate the transport of smoke and heat inside multi-compartment buildings with complex ventilation. These capabilities are of particular importance in DOE facilities where the performance of the ventilation system is required to prevent the radiologic release of material during a fire. FSSIM has been developed to include HEPA filtration in mechanical ventilation systems, which can account for additional resistance due to soot accumulation on filter media. Extensive verification and validation exercises have been performed to demonstrate the applicability of FSSIM, including the LLNL fire cell tests. The facility performance can then be evaluated against defined failure criteria for the HEPA temperature and pressure drop, as well as loss of containment due to zone pressurization. FSSIM is a desirable design tool in this application, given its computational efficiency and flexibility in modeling highly complex facilities. These advantages allow for realistic evaluation of protection strategies to effectively mitigate the risk of radiologic releases during a fire.

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Author Bios:

Justin Williamson is a fire protection engineer with Hughes Associates. Dr. Williamson performs fire modeling analyses in the areas of smoke and heat transfer. Dr. Williamson attended the University of Maryland, where he received Bachelor of Science and Master of Science degrees in Fire Protection Engineering in 2001 and 2004, and a Ph.D. in Mechanical Engineering in 2009.

Craig Beyler: At Hughes Associates, Inc., Dr. Beyler has planned and conducted experimental and technical studies of a wide range of fire protection problems for federal, military, civilian, and private sector clients. He has performed several analytical and experimental projects over the last several years in support of DOE facility fire protection assessments, fire hazard analyses (FHA), and safety analysis reports (SAR). These analyses included the use and development of modeling. These efforts required application of small and large scale experimentation along with fire modeling of unique process and facility conditions. He has acted as technical reviewer on dozens of FHAs and reports, which support FHAs.

Jason Floyd is a senior engineer with Hughes Associates. Dr. Floyd's experience includes both testing and numerical simulation. Dr. Floyd has performed both large and small scale fire testing, including testing evaluating the performance of detection systems for Navy ships. He is the lead developer of Fire and Smoke Simulator being used by multiple US Navy ship development programs. Prior to his employment with HAI, he was a National Science Foundation Post-Doctoral Fellow at the NIST Building and Fire Research Laboratory where he worked on the development of FDS v2 and v3. He is currently working with NIST to develop FDS v5. Dr. Floyd received his Ph.D. in Nuclear Engineering from the University of Maryland.