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Aerosol Leak Path Factors, Fire Scenarios, and Active Ventilation

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Abstract

Fire scenarios and scenarios with prolonged energy and aerosol release feature a wide variety of phenomena that influence the transport of contamination throughout a facility and to the environment. This paper describes key factors affecting the leak path factor in fire scenarios. An example facility is described that has many natural and engineered features to mitigate releases, and it is built around a fire compartment used for a well-known set of experiments and code validation exercises. The paper briefly discusses the FATE™ computer program, which is designed to calculate leak path factors during normal processing and accident scenarios at fuel cycle facilities, and has combined models for fire (like CFAST) and the facility (like CONTAIN or MELCOR). FATE is employed to calculate results for static confinement (no HVAC) and active confinement for several configurations of the example facility. Key lessons are: (a) The LPF can be similar in active and static scenarios in a well-designed facility provided that leak-tightness is maintained, (b) The configuration of ductwork and leak paths can dramatically affect the LPF in static scenarios, but has little impact in active scenarios, which is the virtue of active confinement, and (c) Two key factors that can prevent the success of active ventilation are supply isolation failure and soot buildup on filters.

Purpose and Focus

The DOE safety community is well aware of the requirement to analyze the need for active ventilation and the need to provide safety categories for HVAC system components in the wake of DNFSB recommendation 2004-2. Such analysis and categorization presupposes an analysis technique that can cope with diverse facility sizes and ventilation designs, with the potentially unknown configuration of doors and leakage paths, and system response to environmental factors such as high temperature, pressure differences, and soot loading. It is not necessarily straightforward to a priori identify bounding facility configurations and scenarios.

The purpose of this paper is to identify and describe facility design features that affect the leak path factor (LPF), the fraction of material released in the facility that is transported to the environment. The focus of this paper is to compare active (HVAC operating) and static (HVAC not operating) confinement results and demonstrate the impact of facility configuration.