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Interaction of a Complex Ventilation Network with a Confined Room Fire: Application to Nuclear Facilities

Abstract

In nuclear facilities, compartments are generally sealed from one another and connected through a complex ventilation network. In normal operating conditions, such network ensures a dynamic confinement through a pressure cascade that prevents the release of hazardous materials to the atmosphere. In the event of a fire in a confined room, the pressure increases because of the release of hot combustion products. The ventilation conditions are thus altered. In this thesis work, the interaction between a complex ventilation network and a fire has been studied numerically using a Computational Fluid Dynamics (CFD) code, namely the Fire Dynamics Simulator (FDS6). This work is a part of an international research program called PRISME.

The work of the thesis has been divided into two parts. In first part of work, the set-up and validation of given ventilation network and available experimental data has been done (without fire) using FDS 6. After proper validation of HVAC set-up, ventilation system interaction with fire in the room has been studied. Here the purpose has been to study the pressure and volumetric flow rate profile with the effect of fire on them in FDS and to check if FDS is able produce the same pressure and volumetric flow rate profile as recorded in the experiment. Sensitivity studies have also been done for various input parameters for HVAC in FDS.

A complex ventilation network (without fire effects) with fans having constant volume flow characteristics has been successfully validated in FDS. Moreover, a simple ventilation network with quadratic characteristics fans having fire effects has also been validated, which also substantiates the FDS capability to model ventilation network having the effects of a fire.