Smoke transport in ventilation systems with fire dampers without smoke release mechanism

Summary report

In the discussion on the analysis of fire protection for ventilation systems according to DIN 18017 having fire dampers within the floors the question was raised, whether or not this concept of ventilation system leads to danger of smoke transmission from one compartment to others. It has to be analysed, whether fire gases, for which by a closed damper in the floor above the fire compartment the way upward is cut, will stream downward and enter into compartments below the fire compartment. In order to answer this question an investigation program with realistic fire scenarios was carried out.

The tests within this program which used the standard time temperature curve according to DIN 4102 part 2 showed, that with an arrangement like in practice only a small amount of smoke was moving downward. Apparently the transmission of larger amounts of smoke was restricted by buoyancy within the duct.

Simulating an air supply and air exhaust of bathrooms and toilets like in practice only very specific and unfavourable conditions allowed a quick combustion of the combustible products and created even in spite of rather low temperatures a thermal volume increase of the gases and pressure conditions which lead to a smoke transmission to a lower compartment after the way upward was closed by a fire damper. By a rather large number of tests the conditions were examined, which must exist for this and which led within a period of about 15 minutes to a smoke obscuration of the compartment below the fire compartment.

The most important conditions for this are a small size of room, rather low ventilation openings (e.g. overflow-openings in a door) and a fire load, which even under reduced oxygen conditions and a small primary fire with low temperatures in the room lead to a rapid combustion. The possibility of smoke transmission which occurred in the test, is only relevant in case of a fire / fire phase, during which the temperatures in the room lead to releasing and closing of the fire damper in the floor above the fire compartment but are not high enough to close the fire damper in the floor below the fire compartment.

In the analysis of the results of the test program the probability of occurrence of the specific conditions identified in the tests have to be taken into account as well as the potential danger for persons by the amount and nature of the smoke transmission observed in the tests. It can be stated, that the conditions for a smoke transmission by the ventilation ducts in practice have to be expected seldom. Furthermore it turned out that the transmission of smoke is occurring with a low speed so that even for disabled persons in the room below the fire compartment a sufficient long time for escape is available and a considerable danger does not exist. Modifications of ventilation systems already installed in buildings therefore do not seem to be necessary.

The amount of the transmitted smoke was estimated not to comply with the object of the requirements of § 14 MBO. The experiences gained within the test program however should be taken into account for future applications of fire dampers in ventilation systems according to DIN 18017.