

# Fire spread in school buildings subjected to arson fires



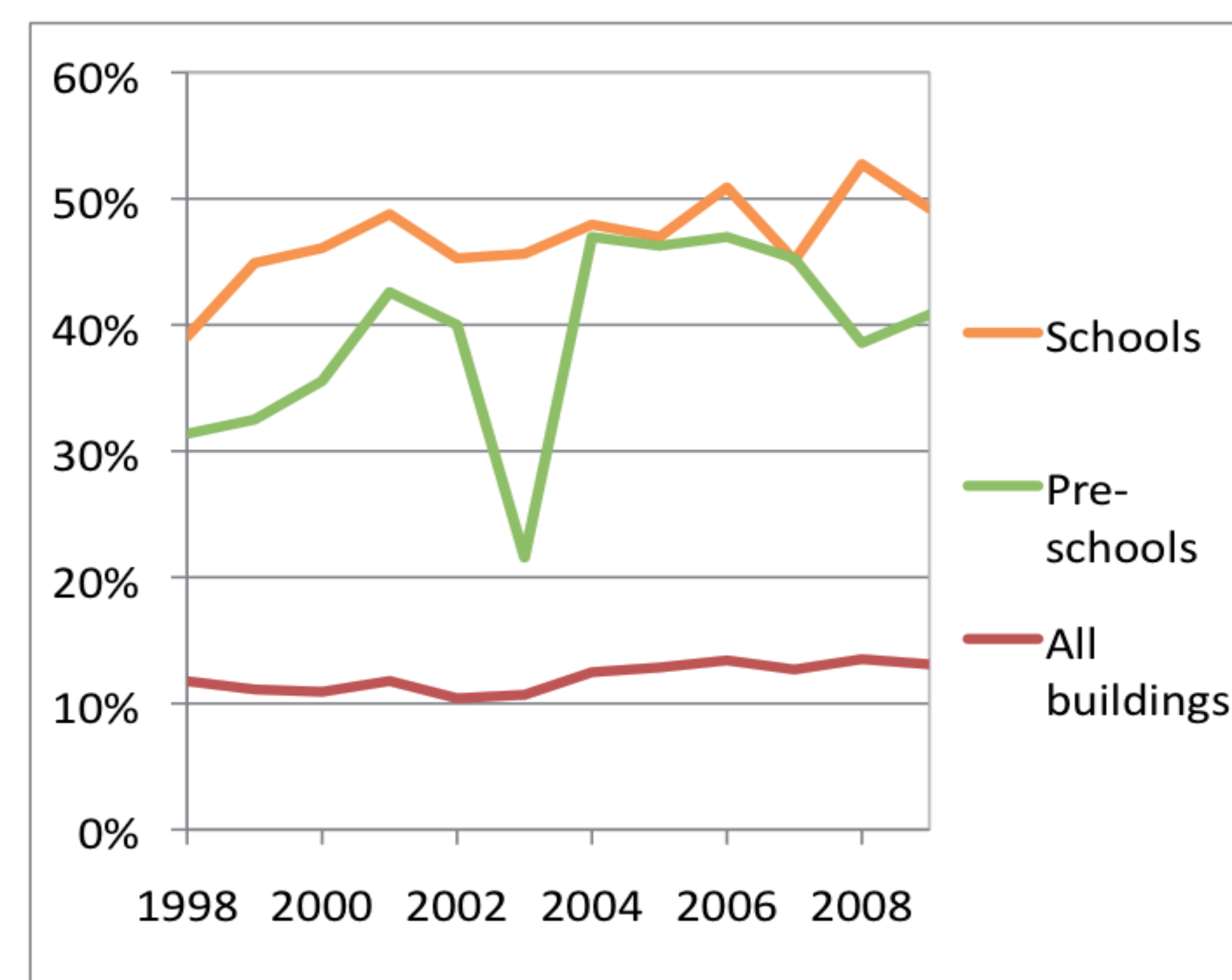
## Use of case studies to determine technical deficiencies



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### BACKGROUND

Arson fires are a large societal problem in Sweden, 10 to 15% of all fires occurring are caused by arson. In school buildings it is more than 40% of the yearly 400-500 fires. The cost of fires in school buildings are around 500 million Swedish crowns (50 million Euros) yearly which are more than 10 % of the total cost of fires in Sweden.



This diagram illustrates the percentage of arson fires for "schools", "pre-schools" and "all buildings". It is clear that arson fires is a problem in school buildings.

### OBJECTIVE AND METHOD

In this project [1] knowledge on technical factors that influence the spread of fires caused by arson are obtained with the help of case studies of 60 arson fires. The following five factors were studied and evaluated in the case study:

- Room/place of origin
- Ignition source/first material ignited
- Spread of fire
- Time to detection and fire service notification
- Building properties (e.g. age and type)

### TYPICAL FIRE SCENARIOS

| Nr | Description   | Location                                       | Initial HRR (kW) |
|----|---|--|------------------|
| 1  | Fire lit in combustible materials in secluded area during school hours. | Inside school building.                        | 20-200           |
| 2  | Flammable liquids ignited.  | Thrown through an opening                      | 100-500          |
| 3  | Fire lit in various combustible materials (wastes) outside the schools, | Outside school building, closed to the façade. | 20-500           |

### SUMMARY OF RESULTS

The fires are commonly lit in secluded areas.

Common materials are:

- Combustible wastes
- Fireworks and flammable liquids
- Materials indoors are mainly small waste baskets.

The most severe fires start outside and spreads up along the façade and in to the attic. If the attic is not divided into fire compartments the fire can spread along the entire building and have in some cases spread to the classrooms below. The fires that have started indoors are generally kept smaller

The following technical deficiencies have been identified:

- Lacking of detection systems and automatic fire alarm systems
- Poor construction of roofs and attics
- Insufficient or malfunctioning fire compartments.

Solutions can be comprehensive automatic alarm systems with efficient location of different type of detectors (smoke and heat detec-

tor cables), good illumination, other types of façade materials, surveillance cameras and sprinkler systems.

Good examples of technical systems have also been identified, such as camera surveillance, comprehensive fire detection system for entire buildings (including attics and facades), quick and efficient acting from the fire service.

### THE USE OF CASE STUDIES

Much can be learned from Swedish fire investigation reports. Case studies can be a valuable complement to an analysis of fire statistics, specially when analysing fire spread.

### ACKNOWLEDGMENTS

The research presented has been conducted within a multidisciplinary project initiate by The Swedish Fire Research Board (Brandforsk) in 2007. More details about sponsor can be found in the project report [1].

### REFERENCES

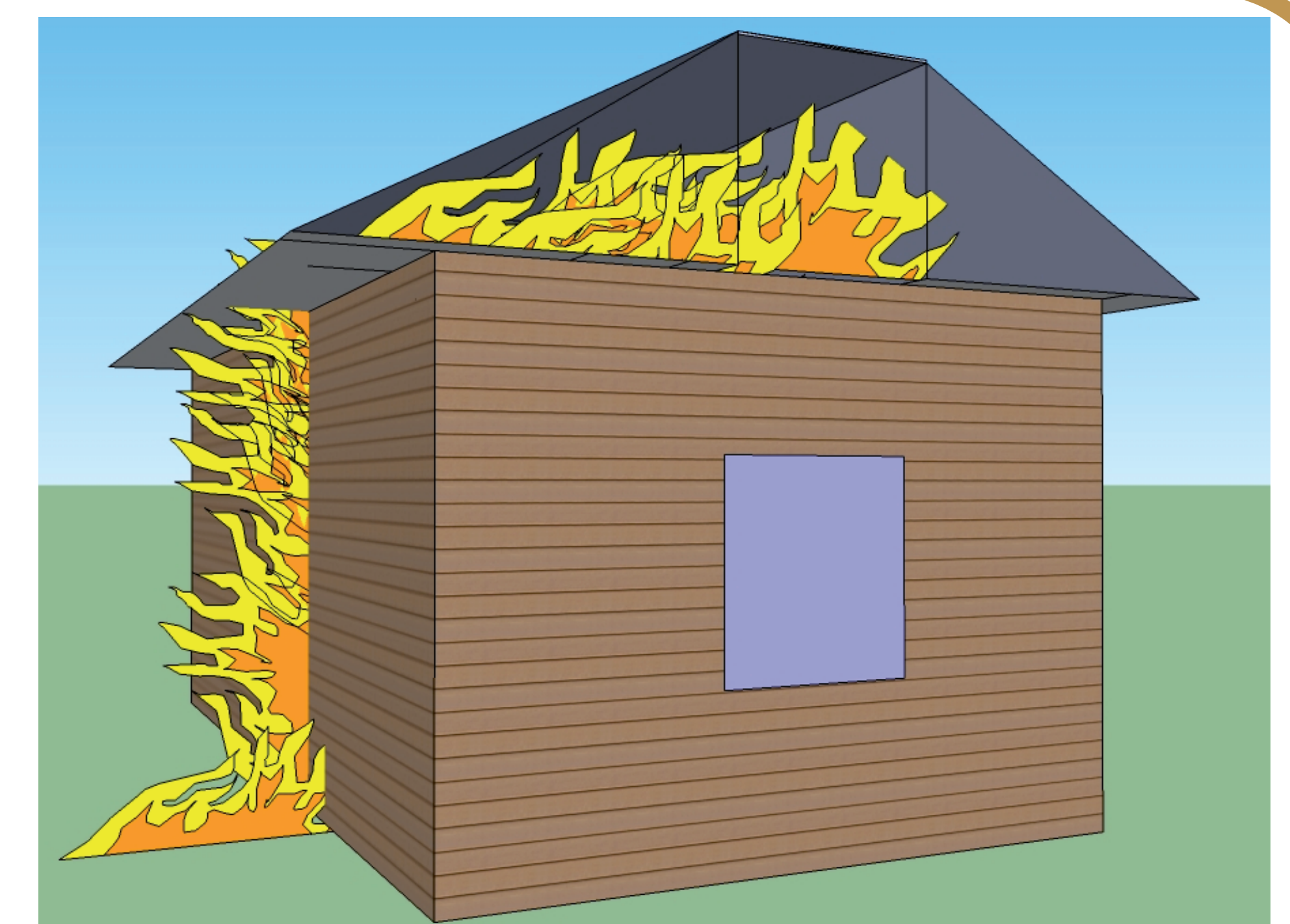
1. Van Hees, P., Johansson, N., Fallstudier – Vilka tekniska faktorer spelar en roll vid anlagd brand i skolor?, Report 3148, ISRN: LUTVDG/TVBB--3148—SE, Lund (2009) in Swedish.



A typical ignition source has been found to be molotov cocktails or flammable liquids that are thrown into the school buildings. In this case the fire did not spread to other items.



A typical fire scenario that causes great monetary loss. A fire is deliberately lit outside the school building and has spread to the roof and attic of the school. The fire was devastating and 2/3 of the school was destroyed in the fire.



An illustration of the most severe type of fire. The fire is lit close to the facade and spread up along the building to the attic where it develops rapidly.