(1) Abstract Cascade-model for fire develpement

Using a model to analyse fire safety turns out to be a valuable method to improve fire safety substantially. With this the influence factors become visible and also it becomes clear how fire safety can be improved. Also with a good analyses it becomes clear which factors have the greatest influence and where the most safety profit can be achieved.

Fire is a complex phenomenon with a complex damage pattern. The question is not only how fire spreads, but the question is also how smoke spreads (and the effects of this). Many factors can influence the fire and smoke development. And many preventive and repressive measures can be taken to prevent or slow down the fire and smoke development. Fire isn't only a complex phenomenon, it is also a dynamic phenomenon that develops in time and space.

Within the project "Improving fire safety" a model is searched for that would unite these aspects. With the model you must be able to perform quantitative and qualitative analyses. These analyses serve as a foundation for measures to improve the fire safety. Effectiveness and efficiency of these measures can be substantiated with this model.

The project group (see colophon) found such a model in the combination of two already existing models: the (original) Cascademodel and the fault tree model. This model is called the "Cascademodel 2.0***".*** In this rapport on the basis of examples and detailed fault trees a proof of concept of this model is demonstrated. And the usefulness of the model is investigated.

Based on expert judgement and the already present data it is demonstrated that the model offers good perspectives to predict and describe the fire development. The analyses that are done with this model can be more refined in the future by using the Bayesian Belief Network method. A condition for using quantitative analyses is that there is enough relevant en trustworthy data available. The registration and the availability of this information is a point off attention which elaborates in the project 'Improve fire statistics' that is enforced by the ministry of Safety and Justice, CBS (National statistics agency), NVBR (the Netherlands Association of Fire and Disaster Control Services) and VBV (Union of volunteer fire fighters)

(2) Health aspects of Fire fighting

The Effect Of Pre-heating And Intermediate Cooling On Firefighting Performance

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Abstract:
During firefighting activities core temperature (Tc) can exceed 39.0°C and reduce performance. Therefore it is crucial to prevent or delay the attainment of high Tc. PURPOSE: To determine the effect of pre-heating and intermediate cooling on speed and quality of firefighting activities. METHODS: Twelve firefighters visited the Fire Training Center based lab three times. In one trial, they were either pre-heated (HEAT) prior to a search-and-rescue and fire extinguishing task within a fire drill in a burn building. In the other trials, subjects remained thermoneutral prior to the drill and afterwards they were either cooled by forearm immersion in 10°C water (FC) or remained seated in 20°C ambient temperature (CONTROL). After this 20-min recovery period, they performed a second drill. Core and skin temperature (Tsk), heart rate (HR), rating of perceived exertion (RPE), speed, and quality of performance (QoP) were measured during the trials. QoP was ranked by two experienced fire instructors and the subjects themselves. RESULTS: Tc was 0.54 ± 0.20°C ($P<0.05$) higher after pre-heating. After the first drill, Tc was higher for HEAT (38.4 ± 0.4°C) than for CONTROL (37.9 ± 0.2°C; P0.05). Cooling rate of FC did not differ from CONTROL (0.024 ± 0.014 °C min-1 and 0.016 ± 0.017°C min-1, respectively; $P>0.05$). No differences in average Tc and HR were found in the second drill ($P>0.05$). RPE was higher for HEAT than for CONTROL (14.3 ± 2.1 and 12.1 ± 2.9, respectively; P=0.001) whereas no differences were observed between FC and CONTROL (12.4 ± 2.9 and 12.8 ± 3.5, respectively; P=0.93). Although no significant difference was observed in time to completion ($P>0.05$), subjects performed slower in the second half of the first drill in HEAT than in CONTROL and faster in the second half of the second drill in FC than in CONTROL ($P<0.05$). In HEAT, firefighters rated QoP lower than in CONTROL (6.5 ± 0.7 vs. 7.1 ± 0.3, respectively; P=0.02), whereas expert opinion revealed no differences for pre-heating (P=0.39). No differences in QoP were found after forearm cooling ($P>0.05$ for self report and expert opinion).

CONCLUSION: Pre- heating affected pacing of firefighting exercise and self reported quality of performance. Intermediate forearm cooling was beneficial for pacing but not the quality of firefighting exercise.

(3) Prediction of BLEVE

Abstract
First responders are exposed to great dangers in case of an imminent BLEVE. To avoid these risks first responders take prevention and preparation measures, keep distance to the BLEVE-object, and evacuate the immediate surroundings. In order to do so, first responders consider the time left before the BLEVE occurs. Currently, this judgement is based on protocols, theoretical knowledge, and often very less experience. This judgment should be based on identified conditions from a distance to the BLEVE-object: keeping distance is obliged to diminish the risks for first responders in the first place.

This document describes an inventory of possible (sensor)technologies to get a more grounded judgment on whether and when a BLEVE will occur. This is done by first considering a BLEVE itself: a description of a BLEVE, prevention and preparation measures, its effects, conditions under which a BLEVE will occur, and current operation procedures. Second, all information requirements considering a BLEVE are determined: information about the tank wagon/ vehicle, known before an incident (static or object information, see Appendix C), and known during the incident (dynamic or incident information, see Appendix D). Third, based on an exhaustive list of these information requirements, (future) available (sensor)technology is enumerated to match these information requirements.

Three information requirements were determined essential during a workshop with first responders, namely: (delta) pressure in the tank, (delta) temperature of the tank wall where the tank wall is exposed to heat radiation, and the (overall) physical condition of the tank wall.

Overall recommendations for further analysis involve amongst all a pilot study in which:
- current available sensor technology in a tank vehicle/ wagon (pressure gauge, thermometer, etc.) can be read out continuously from a distance.
- a continuous map of all tank wagons/vehicles in use is created, in combination with the measured variables on each tank wagon/vehicle itself. When (a combination of) these variables deviate from their standard values, a warning signal should be reported.
- suggested (sensor) technologies in this documents are implemented on a tank wagon/vehicle, so their true usefulness can be assessed.

(4) Prediction of fire spread and/or collapse of complex buildings

Abstract
The risks of fire in high buildings consist primarily of risks for large numbers of persons therein and secondary (especially in densely urban areas) for bystanders and first responders. How many people have been exposed to this risk will depend on the time of the incident, the use of the building and the place of the building in the area. The safety of first responders will depend on the local circumstances surrounding the site of the fire, and the possible fire spread – due to which building components or even construction elements may lose their strength and mounting and may collapse.
Around the building, structural components such as parts of the facade may collapse, and inside the building dangerous working conditions may prevail. In a later stage of the developed fire it should be determined whether firefighting in the building can be executed safely and in control. The moment control is lost firefighters may be directly threatened by fire and smoke developments or indirectly by the loss of opportunities to safely withdraw and/or safely leave the building.

This document describes an inventory of possible (sensor)technologies to get a more grounded judgment on the risks in high building of fire and collapse hazards. Typically, sensors are used to monitor the condition of the First Responders (e.g. breathing amount, temperature, position, etc.) or to monitor the First Responders direct environment (e.g. surrounding temperature). The approach in this document follows a different reasoning: How can you prevent the First Responder to be the one who, equipped with sensors to determine incident/environmental factors, must enter a danger zone?
This approach started by considering fire and collapse hazards: a description of both, prevention and preparation measures, their effects, conditions under which they will occur and increase, and current operation procedures. Second, all information requirements considering fire and collapse hazards are determined: information about the building, known before an incident (static or object information, see Appendix A), and information known during the incident (dynamic or incident information, see Appendix B – C). Third, based on an exhaustive list of these information requirements, (future) available (sensor)technology is enumerated to match these information requirements. However, a technology maturity assessment has not been carried out in this context.

As a summary: in case of a fire, for example, on the 13th floor of a building, possibly other sensors, different observation positions, and different information usage positions are required at different stages of the fire-fighting process:

1. Inside the building:
   a. Before and during reconnaissance building information systems and any special built-in sensors may be used. These include sensors connected to steel structure or measuring devices that measure temperature and pressure in shafts. These sensors allow for following the behaviour of the building construction and the development of fire.
   b. During incident attack, sensors that provide information about, for example airflow and ventilation, heat generation around fire place, in shafts, etc. can be placed.
   c. A variant is that sensors are placed that monitor the security threat of the escape route (smoke, temperature development) of the First Responders and support decision making to ensure employability.
   d. With impending withdrawal temporary monitoring sensors can be placed round (upper, lower, around) the area where the fire occurs, and allow for remote reading.

2. Outside the building:
   a. During reconnaissance, monitoring support is needed to overcome the limitations raised by building complexity, height, darkness and weather conditions.
   b. During incident attack, monitoring support must be deployed to observe and track a variety of phenomena from outside the building:
      i. The development of the fire
      ii. The identification of critical situations
      iii. The reaction of building components and the building as a whole
   c. Different perspectives are conceivable: around the building at ground level, around the building at heights (helicopter, another building), at high altitude from above (helicopter, satellite).

(5) Tenability of inhabitants in the home environment during a fire

Summary

Of the total number of fatalities in fires in the period 2001 to 2008 in the Netherlands, approximately 85% of the victims died as a result of a fire in a home or residential building. That is why the Nederlands Instituut Fysieke Veiligheid (NIFV) has started a research in recent years into fatal residential fires. The information available up to now, is too limited to draw firm conclusions. However, furniture and mattresses are apparently often involved in these fatal fires. These type of Fires seem to have a very rapid fire development, thus leading to a limited period of time to take effective actions, in order to be able to survive the fire. In other words, the question is:

On the basis of the problem as stated, the aim of the study is:

The research data of the NIFV show that half of all the victims were found in the room where the fire had started. The "survival time" has been insufficient in these cases. A second remarkable fact is, that, for the elderly people (65 +) the chance to die in a residential fire is **three times higher** than that for people younger than 65 years.

Further investigation of experiments with residential fires in America have shown, that contemporary furniture and mattresses result in a very fast growing fire. Flash-over took place in a test fire with contemporary furniture within three and a half minutes, while the same test with furniture produced around 1975, flash-over took place after seventeen minutes. A room fitted with furniture from the fifties even took thirty minutes to reach flash-over. The experiments confirm the findings obtained in the Dutch research program, that the survival time in fires with furniture or mattresses (in a number of cases) is too short to survive the fire, especially when there are people in de building with reduced mobility, such as can be expected from elderly people.

The "survival time" is determined by: the extent to which heat and harmful substances are produced by the fire, and the extent to which a person can withstand the effects of that fire.

Fire experiments provide valid information about the rise of temperature and about the concentration of irritant and toxic substances that result from a fire. Information about the extent to which heat and gases effect the human body in a way that a person is no longer able to

What is the "survival time" in which residents can still flee from a dwelling and what measures are technically and economically possible and feasible, to reduce the number of victims and severely injured occupants in residential fires?

The aim of this research is to define the measures to increase "survival time" in order to reduce deaths and injuries at residential fires. Secondly, the goal is to determine how Fire Safety Engineering can be used as a tool to determine what the "survival time" is.

Brede Bachelor of Engineering – FSE ix 2010/2011act effectively and subsequently will die from the fire, is available. There is an international standard, issued in 2010 by the International Organization for Standardization (ISO), that provides the means to calculate whether people get incapacitated or even die, based upon a particular fire gradient.

The experiments have shown that incapacitation can be reached within a few minutes after the fire started. Measures that prolong the survival time provide an greater survivability, leading to a lesser number of fatalities and badly injured inhabitants of domestic buildings. The possible measures have been assessed by

ease of implementation, effectiveness in prolonging the survival time, economically affordability and finally on the acceptability by the residents. A number of measures have emerged from the analysis, that meet the prescribed criteria. These are considered applicable in the Netherlands. Some examples are:

introduction of fire safe furniture, mattresses, upholstery and fire-safe cigarets, further promotion of fire alarms in homes in the rooms with the greatest risk and the improvement of the awareness of people about the correct use of the detectors, application of home sprinklers systems, and use of escape hoods, in particular for disabled people.

In about half of the fatal fires, furniture or mattress is known to have had a profound influence. Measures to do something about it are well known. For the other half of the fires a clear picture of the main factors that make fatal fires possible, is not yet available. Therefore, it is recommended that the increasing number of fire investigation teams in the different regions, will start to consequently research all fatal and non-fatal residential fires. Information from those investigations should be made available for anybody so that a better understanding of the causes of fatal home fires will arise and appropriate action can then be taken.

To get the proposed measures implemented it is recommended that, with the assistance of experts, a marketing strategy for the introduction of fire safety projects should be developed. Informing stakeholders about the conclusions and recommendations in this report, is necessary to enable them to contribute to the improvement of the survival time and thereby reducing the number of fatalities and serious injuries in domestic fires in the Netherlands.

In this research study, information became available that in residential fires, where windows and outside doors are closed, the fires will not have enough oxygen for a constant growth. Experiments by Underwriters Laboratories (USA) have shown that such a fire can produce life threatening circumstances within 100 to 200 seconds after the fire brigade enters the house. The reason therefore is, that the extra oxygen supplied by the opening of doors and/or windows can lead to a renewed and rapid development of the fire. Further research into this result is needed to make sure that the firemen are well aware of these risks and act appropriately.

(7) domestic sprinklers

ABSTRACT
Fire fighting water demand has a significant impact on drinking water quality during its transportation phase. Most of drinking water distribution networks (DWDNs) are oversized because of fire fighting water demand and thus, low velocities and large water age can be observed in a distribution network. According to that, favorable environment for physical, chemical and microbiological processes can be created. As the consequence, water discoloration and increased microbiological risk can be observed.
The number of fire deaths stay almost in the same level in the last years in Europe. At the same time, around 80% of fire deaths occur in the domestic environment. One of the most important reasons why the number of fire victims does not decline is that the effective available time to escape a fire has been reduced from 15-17 minutes to around 3 minutes. This is mainly because of the change in building materials to plywood, synthetic fibers and foam in a modern house decoration. As a consequence, fire develops quicker and fire fighters have to deal with larger fires.
Application of residential fire sprinkler systems on a large scale has been postulated as one of the most promising solutions how to avoid water quality problems during its transportation phase and how to noticeably reduce fire deaths in the domestic sector. Therefore, the breakthrough in both sectors is needed in order to achieve previously mentioned goals.
The first part of the research has been devoted to the analysis of hydraulic performance of fire sprinklers. The deterministic model of atomization process has been developed. The model showed that among different parameters such as: discharge, pressure, orifice diameter and radius of deflector, the orifice diameter might have the biggest influence on the droplet formation process. Two novel parameters, theoretical heat capacity (THC) and evaporative heat capacity (EHC), have been defined. Analysis has showed that despite the low flow and low pressure conditions in drinking water distribution networks (DWDNs), the fire suppression process could be as effective as under higher flows and pressures, thanks to the evaporative cooling by smaller droplets.
The second part of the research was focused on the implementation of fire sprinklers in residential buildings applying the SIMDEUM (**SIM**ulation of water **D**emand; an **E**nd-**U**se **M**odel) model. Results have revealed that water age of cold water could reach about 10 hours at the most distant locations. The comparison of layouts has showed that the water age was almost the same despite the extended length of pipes. Therefore, it was concluded that water age was mainly influenced by tap patterns. At the same the refreshment rate of the system per one hour was reduced. The conventional layout of drinking water system was refreshed around 4 times more compared to the integrated system.
Keywords: atomization process, distribution network, drinking water installations, drinking water quality, fire fighting water demand, fire sprinklers, SIMDUEM model.

(8) study into fire scenario's in underground parking lots

Summary

'Fire Scenarios Parked?'

At the fire in car park 'De Appelaar' in Haarlem in 2010 and the fire at the car park in the Lloydstraat in Rotterdam in 2007 respectively nineteen and seven cars were totally burned. The guidelines for car parks on the other hand, are based on a design fire of three cars maximum. This has been the reason for the fire department of Apeldoorn and fire engineering consultancy DHV to give the assignment to investigate the fire scenarios that may occur in an underground car park.

The objective of this study, under the HBO program Broad Bachelor of Engineering with graduation profile Fire Safety Engineering at the Hanze University Groningen, is to better understand fire scenarios that may occur during a fire in an underground car park at the time the fire brigade arrives at the scene. The knowledge gained can be used by the fire department of Apeldoorn to develop a fire fighting strategy in underground car parks. By understanding the fire scenarios DHV and the Risk Control department of the fire department of Apeldoorn can adjust fire safety measurements in the designing process accordingly.

The study is limited to underground car parks with a surface area bigger than 1,000 square meters until the time the fire brigade arrives at the scene. The implementation of the research has been based on literature research, statistics, fire investigation and field tests. Analysis of research data in combination with a probabilistic and physical approach, have determined two fire scenarios. In addition, a risk analysis model (the cascade model) will be proposed which can be helpful tool to determine specific fire safety measurements in order to control the fire.

The time the first fire engine arrives is the foundation for the timetable of the fire scenarios. The time the fire brigade arrives at the scene is starting to get longer and there is even a tendency that this is increasing from 8 to 15 minutes. With a fire alarm system and a direct alarm to the fire department, a time saving of 10 minutes can be achieved upon the arrival time. The total time from the start of the fire until the arrival of the fire engine varies from 11 to 30 minutes. In the draft standard NEN 6098, this time is set on 15 minutes.

Analysis of the field tests shows that the realistic heat release rate (HRR) of a car from five to eight years old is 8 megawatts and has a total calorific value of 9,500 megajoules. The amount of cars burning at the time the fire brigade arrives depends on many factors. It should be taken into account that fire spread will occur to both sides of the burning car and in case of a double parking space the fire could also spread to the car parked in front of the burning car. The guidelines used to design fire safety measurements in car parks only determine a fire spread in one direction. In addition a lower heat release is used, based on research of cars from the nineties. The two scenarios in this report will provide support for determining the fire growth and its total heat release. The heat release rate in time may quickly rise up to 26 MW after 30 minutes.

Fire in car parks cause a lot of smoke and can be a big problem for the fire brigade in action. This is mostly due to the use of plastics in cars. In the near future the use of plastic in the car industry will increase. Further investigation of the smoke production and heat release of recently built cars is necessary.

Secondary fire load will have a negative influence on the fire scenario in underground car parks. To prevent fire spread and smoke development in an underground car park by secondary fire load, it is recommended not to allow storage and flammable construction materials in car parks.

'Brandscenario's Geparkeerd?' - 2011 XISmall car parks (<2,500 m2) may be a bigger risk for the fire brigade than large car parks. Depending on the existing ventilation, in small car parks there is a realistic chance of flashover or backdraft. It is therefore recommended that also small car parks should also be provided by a smoke control system or by an automatic extinguishing system with a direct alarm to the fire brigade.

In car parks with a fire compartment bigger than 1,000 m2 a smoke ventilation system or an automatic extinguishing fire system is applied to be a fire safety measurement equal to the Dutch building code. A ten-fold ventilation system according to the LNB-guidelines will not provide sufficient safety for the fire brigade to attack the fire inside the car park. The fire brigade will still be confronted with a dense wall of smoke. It is therefore recommended not to allow this type of ventilation any more. A smoke control system that creates a smoke free approach zone for fire fighters ('view on the fire') can improve safety conditions for fire fighters. However it is important that the smoke control system is dimensioned on the right design fire and the Computational Fluid Dynamics (CFD) simulations has to be made by experts. The smoke free approach achieved in practice is questionable, because it also depends on many influence factors as described in this report. An automatic extinguishing system appears to be very effective. From field tests in car parks and tunnels it has been proved that the fire is limited to one car.

In a greater or lesser extent many factors can have its influence on the fire scenario. Analyses of these influencing factors show that no direct answer can be given to the question which fire scenarios can occur in an underground car park. It can no longer be assumed that only one fire scenario can be used to design a smoke control system. No car park is the same. The actual response time, in combination with the fire scenario at the time the fire fighters arrive and the complexity of the building, together with its influencing factors will determine which level of fire safety is needed for the fire brigade to attack the fire inside the car park. General conclusion of this report is that for designing and assessing car parks, a customized risk-based analysis is required, for which the scenarios in this report can be taken as a starting point. The many in this report identified influencing factors will provide a basis to determine the context of the risk analysis. On one hand the cascade model can be a helpful tool to find an answer to the possibility to attack the fire in the car park. On the other hand, in the process of designing a car park this model can be helpful to apply fire safety measurements according to the desired level of fire safety and firefighting intervention, followed by risk analyses. Although this investigation provides no concrete scenario, it will help to understand and to judge the fire safety and the firefighting in underground car parks.
Fire scenarios in car parks have been 'parked' too long. It is time to move on!

10. Influencing behavior of car drivers when confronted with emergency vehicles'

Introduction:
In 2011, NIFV conducted an exploratory study into the current and desired behavior of car drivers, when they are confronted with emergency vehicles. In this project, preliminary advice for car drivers were stated. It was also found that there are different opinions between and within police, fire and ambulance organizations on how a driver of an emergency vehicle should behave in specific situations.
In 2012, NIFV conducts a follow-up study on how the interaction between car drivers and emergency vehicle drivers can be improved. This project looks at several aspects that (may) influence this interaction. The study consists of three parts:

1. A survey of car drivers
2. A simulator study, in which three factors on human behavior are tested:
   a. giving behavior advice
   b. an early warning system in the vehicle of the traffic participant
   c. Defensive/passive behavior of the driver of the emergency vehicle instead of offensive/dominant behavior
3. The organization of a number of discussion meetings, where the focus is on predictability of the behavior of emergency vehicle drivers and their training.

The project has started in the spring of 2012 and will be concluded with a congress at the end of 2012.

Field of interest / working on:
In The Netherlands we would like to know more about this, and we will use the knowledge to improve the training of drivers of emergency vehicles.
We will combine information from the survey, the experiments with the simulator and the outcome of the discussion meetings.

Drivers of emergency vehicles are regularly confronted with behavior of the traffic participant that deviates from the desired or expected behavior. In certain cases this leads to unsafe conditions and a longer response time.
In the Netherlands, priority-1 vehicles ('voorrangsvoertuigen') are vehicles of mainly police, fire departments and ambulance services, which use a blue light beacon and a two-tone horn to indicate that they have an urgent task.

Drivers of emergency vehicles may ignore certain traffic rules and signals, such as the maximum speed limit, ignoring commandment or prohibition signs and driving through red traffic lights. However, the security hereby has to be observed.
For drivers of emergency vehicles there are guidelines that specify how they can drive safely and responsibly with optical and acoustic signals. Also, drivers of emergency vehicles get special training.
It is not described for car drivers how they can let an emergency vehicle pass in a safe and responsible way. There are no guidelines in law, nor in the curriculum for obtaining a license, nor elsewhere. There are several initiatives and innovative products in development that provide car drivers with an early warning of an approaching emergency vehicle.

The study of 2011 had five research questions. Based on literature study, an exploratory film analysis, a survey of more than 2000 drivers of emergency vehicles and an expert meeting, we now know more about the current knowledge of and experience with the behavior of car drivers. This and based on opinions of the drivers of emergency vehicles and the consulted experts, there is an initial approach to the preparation of (behavioral) advice for car drivers. In the study of 2012, the focus will be on improving the interaction between car drivers and emergency vehicle drivers.

Abstract NVBR pilot study: the effects of behavioral interventions on fire safety in student residences

College students are an important target when it comes to decreasing fire hazardous behavior. We developed 3 social psychological interventions, translated them to stickers that could be applied to walls in student homes and tested them in a field study in 3 Dutch cities with a large population of students: Rotterdam, Utrecht and Nijmegen. In each city 1 specific intervention was tested by the fire department. The interventions focused on either smoke detectors (Rotterdam) or blocked escape routes (Utrecht and Nijmegen).

In each of the 3 conditions, members of the fire department visited student residences on 2 occasions. During the first visit they scored the fire safety of the house on a specially designed instrument and then applied the sticker(s). During the second visit, which took place several weeks later, they scored the fire safety of the house again. The scores of the student residences in the 3 conditions were compared to those of a control group that did not receive stickers with an intervention.

In this study, the sticker that displayed a descriptive norm proved to be a very effective method to get students to take measures towards fire safety. It triggered students to keep the main entrance and other escape routes free from obstacles (e.g. garbage bags, crates etc.). Also the equipment present in the kitchen (gas/ electric appliances/ range hood) was less dangerous after the stickers had been placed. Additionally, the overall hygiene in student houses improved. A remarkable finding, because this particular sticker focussed on smoke detectors.

A sticker with an injunctive norm also showed measurable effects. This intervention led students in to keep extra escape routes free from obstacles.

However, the third intervention – a prompt – did not lead to any significant results. Perhaps because it is not common knowledge among students that keeping clutter on your stairs and blocking your entrance poses a threat in case of a fire.

Abstract NVBR pilot study: the effects of two types of fire education on children and their parents

There are numerous methods to educate children in elementary school about fire and fire- safety. We evaluated two of them: (1) a curriculum on fire-safety, taught by a teacher and (2) an educational talk by an official from the fire department. Two schools were assigned to each of these conditions. In each condition, pupils (ages 10-12) and their parents were surveyed both before and after the education took place. In 4 control groups (comparable schools), pupils and parents were also surveyed at 2 different times. The survey was based on the content of both educational methods. The effects were measured by comparing the results of the before and after surveys within each school, and by comparing the educational conditions to the control groups.

Both methods proved to be effective. Answers on several items in the survey improved after both the curriculum and the talk by the official. However, the curriculum had slightly more effect on pupils. For parents, there were no differences found between the effects of the methods.

The results show that the majority of the pupils already knew the right answers to many of the survey questions before the fire education took place. This may indicate that the content of the educational methods was too easy for children aged 10-12. There were also some survey questions that showed little to no improvement in knowledge after the education had taken place. Perhaps these topics received too little attention and elaboration in the educational methods.

Therefore, an important recommendation is to modify the current curriculum. Perhaps an update would suffice to boost the effect. This study also confirms that educational methods that are meant for children, also have an effect on their parents (though this is only a small effect). For this reason it is advised that the curriculum is expanded to also cover the subject of fire-safety in your own home, to stimulate communication about this topic with mom and dad.

A combination of the curriculum and a visit from the fire department official is highly recommended. A visit from the fire department official appeals to the imagination of the children. When this is combined with the cognitive input from the curriculum, the results can be fruitful because both methods each have distinct positive effects on memory and retention.

Also among the control groups (which did not receive any form of fire education) there was some increase in knowledge measured. Merely asking the kids about fire safety may have indirectly affected their knowledge by stimulating them to talk about it at school or at home with their parents.