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Fire and fire protection in homes and public buildings

An analysis of Swedish fire statistics and fire protection strategies

SWEDISH CHEMICALS INSPECTORATE

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An analysis of Swedish fire statistics and fire protection strategies

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Preface

Controlling the risks posed by chemicals is an important part in working towards an environmentally sustainable society. However, it cannot be seen as an isolated issue. When considering risk management measures for substances used as flame retardants, it is necessary to take also fire safety issues into account. Increased knowledge about fires enables us to make better decisions to ensure a high level of protection for future generations, from fires as well as dangerous substances.

This report was commissioned by the Swedish Chemicals Inspectorate (KemI) in order to learn more about Swedish and Nordic fires including their causes and consequences. The study of fire statistics has been carried out by the National Centre for Learning from Accidents at the Swedish Rescue Services Agency. An analysis of fire protection strategies as described by leading Swedish experts was also performed.

Sixteen national environmental quality objectives, adopted by the Swedish Parliament, describe what quality of the environment and natural and cultural resources that are environmentally sustainable. “A Non-Toxic Environment” is one of the sixteen objectives and defines the aim of Swedish chemicals control. This report has been funded by the Environmental Objectives Council, responsible for the coordination of the objectives. By repeating similar studies of Swedish fire statistics it can be ensured in the longer term that a high level of protection against fires is maintained while working towards an environmentally sustainable society.

This report provides important knowledge for decision-making concerning flame-retardants. The links between improved chemicals management and fire-safety will be of great national and international importance for some time to come. It is therefore our hope that this report can contribute also to the work carried out in other countries.

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Swedish Chemicals Inspectorate

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Summary

Fire statistics

On average there are about 100 fatal fires per year in Sweden. The number of fatal fires fluctuates widely. An example of this was 2004, an exceptional year with only 62 fatal fires recorded by the Swedish Rescue Services Agency. It is very rare for a fatal fire to claim more than one victim. Most fatal fires occur in homes, often starting in a bed, sofa, other loose fittings or clothing. Carelessness when smoking is the most commonly identified fire cause. The homes where fatal fires occur are rarely protected by smoke detectors. This is in marked contrast to Swedish homes in general (in 2001 about 65 % of households had functional smoke detectors).

In Sweden the death rate from fire has fallen by about 35 % since 1945 – a change which is wholly attributable to the marked fall in the death rate for burns in males aged between 15 and 64. It is impossible to identify what lies behind this dramatic improvement from an analysis of published statistics, but the level of smoking has reduced greatly over the years. Fire death rates are higher for males than females and are also higher for the elderly than for younger people. Those who are out of work, on low income or living alone also run a greater risk of dying in fire.

The approximate figures for fire injuries per year in Sweden are 100 deaths, 700 major injuries and 700 minor injuries. This corresponds to rates of 11, 80 and 80 per million population respectively.

For accidents in general in Sweden there are about 30 major injuries per death and 200 minor injuries (see Olyckor i siffror, NCO/SRSA). The distribution is quite different for fires where there are only seven major injuries per death, and similar numbers of major injuries as minor injuries. Accidents in general have the ratio 1:30:200 whereas fire has 1:7:7.

Most home fires attended by the fire brigade are quite small. In detached houses most turn-outs are caused by chimney fires which do not spread to other parts of the building. In blocks of flats the most common cause is a cooking appliance being left on. Arson is also a common cause in blocks of flats, though arson is most often observed in stairwells and cellars and is rarely directed at living accommodation.

Arson is the most common cause of fires in public buildings. In these buildings there are potentially many people at risk and is clear that fire safety cannot be based on technical risks alone, but must also deal with deliberate fire setting.

Fire protection strategies

Swedish experts consider that fires develop more rapidly now than they did in the 1960s and that this change is attributable to the increased use of plastics. The plastics in the contents of a building now give off more smoke and toxic gases and lead to fires with a higher temperature. It now can take only two to three minutes for potentially fatal conditions to occur due to the increased amounts and toxicity of the smoke. This makes it more difficult to escape from a fire and a flashover can occur within five minutes of a fire start.

According to Swedish experts, fire safety is considered to be dependent on:

- How individuals behave
- How organisations behave
- The vulnerability of the people exposed to the fire
- The fire properties of products
- The technical fire safety in the building
- The fire brigade's ability to respond to a fire

Focusing on any one of these points and neglecting the others will lead to suboptimal safety.

The Swedish experts consider that many other EU countries have more regulated building laws compared to Sweden, and that the authorities in other EU countries have greater opportunities to impose sanctions. Sweden has a tradition of trying to make those responsible for activities in a building understand the fire problem through advice and education.

Two main strategies for fire protection in the home are increasing the coverage of smoke detectors and increasing fire awareness through information and education, behaviour being identified as the most significant factor in influencing fire safety in the home. The experts consider the strategy of preventing fire spread from one home to another within one hour as having been relatively successful in Sweden.

Over recent decades public buildings have become larger and more complex. Fire compartments have increased greatly in size and more people can be taken in than before. The great danger with fires in public buildings is if fire gases spread to corridors, stairwells and other open spaces. This makes evacuation more difficult and allows the fire to spread to other parts of the building. The rapid rate at which fires develop means that people often fail to realise how quickly they must respond to a fire. The division of responsibility among those involved is also a problem. Visitors rely on those responsible for the activities in the building. However personnel in a building often lack proper training in how to deal with a fire.

Fire protection in public buildings is dependent on organisational factors and technical measures. The fire brigade play a more important role for life saving in public buildings than in the home. The early detection of any fire is clearly vital in public buildings. Education and information are also important so that personnel can deal with a fire in the initial stage of development.

Swedish experts consider it important to quantify the effect that flame retardants have for fire safety. They must be set in a larger context, together with other protection measures. It is also important to improve knowledge on how different flame retardants work. Alternatives must be found for flame retardants with negative consequences for the environment. Decision-making must also be improved so that different kinds of consequences can be taken into account - fire protection advantages must be weighed up against environmental disadvantages.

The dominant cause of fatal fires is carelessness when smoking. Fire safety for smokers could be improved if better ways were found to prevent a dropped cigarette from igniting whatever it falls onto. One way to do this is to introduce fire safety requirements for clothes, bedclothes and furniture. Another way to achieve the same objective would be to introduce cigarettes that do not ignite things when they are dropped. Cigarettes with reduced ignition properties have been developed. These cigarettes are available in other parts of the world and will perhaps

prove a more effective and appropriate way to improve fire safety than an increased general use of flame retardants in clothing and furniture.

It is clear that the elderly and those marginalised in society run a much greater risk of dying in fires than the population in general. The number of old people is expected to increase dramatically in the future. It is also likely that the increase in alcohol consumption will lead to an increase in the number of marginalised individuals with serious alcohol problems. These two trends pose a clear challenge to fire safety in the near future. It is therefore important to find ways to make smoking, using candles and using cookers more safe for these two risk groups, since these causes cover at least 60 % of all fire deaths.

Summary in Swedish

Svensk sammanfattning

Brandstatistik

Det inträffar i genomsnitt 100 bränder med dödlig utgång varje år i Sverige. Antal bränder med dödlig utgång varierar stort. Ett exempel på detta är år 2004 som var ett exceptionellt år då det endast rapporterades in 62 bränder med dödlig utgång till Räddningsverket. Det är väldigt ovanligt att mer än en person omkommer vid en dödsbrand. De flesta dödsbränder inträffar i bostäder och startar ofta i sängen, soffan, annan inredning eller kläder. Den vanligaste identifierade orsaken till dödsbränder är oaktsamhet i samband med rökning. Det är ovanligt med brandvarnare i de bostäder där dödsbränder inträffar. Detta skiljer sig kraftigt med förekomsten av brandvarnare i bostäder i Sverige i sin helhet (2001 hade ungefär 65 % av hushållen fungerande brandvarnare).

I Sverige har antalet människor som omkommer till följd av brand minskat med ungefär 35 % sedan 1945. Minskningen förklaras i sin helhet med en tydlig minskning till följd av brännskada bland män i åldern mellan 15 och 64. Det är omöjligt att genom analys av publicerad statistik identifiera vad det som ligger bakom den påtagliga förbättringen, men antal människor som röker har minskat kraftigt genom åren. Fler män än kvinnor omkommer i bränder och det är också vanligare att äldre omkommer i bränder jämfört med yngre. Arbetslösa, låginkomsttagare och ensamstående löper större risk än andra att dö i brand.

Ungefärliga siffror för personskador till följd av brand är 100 döda, 700 allvarliga skadade och 700 lätt skadade. Detta motsvarar 11 döda, 80 svårt skadade respektive 80 lätt skadade per en miljon invånare.

Generellt för olyckor i Sverige går det 30 svårt skadade respektive 200 lätt skadade för varje dödsfall (se Olyckor i siffror, NCO, Räddningsverket). Fördelningen skiljer sig för brand där endast sju svårt skadade respektive sju lätt skadade inträffar för varje dödsfall. Med andra ord har olyckor generellt förhållandet 1:30:200 medan bränder har ett förhållande på 1:7:7.

De flesta bostadsbränder som leder till insats av räddningstjänsten är ganska små. De flesta brandutryckningar till villor beror på bränder i eldstäder (soteld) som normalt inte sprider sig till andra delar av byggnaden. I flerbostadshus är den vanligaste orsaken glömda spisar. Anlagda bränder är också en vanlig orsak i flerbostadshus, även om anläggandet av bränder oftast sker i trapphus och i källare och sällan i själva lägenheterna.

Anlagd brand är den vanligaste brandorsaken i offentliga byggnader. I dessa byggnader kan det potentiellt vistas många människor och brandskyddet kan inte bara baseras på ”naturliga” brandorsaker utan bör också hantera anlagda bränder.

Strategier för brandskydd

Enligt svenska experter utvecklas bränder snabbare idag jämfört med vad de gjorde på 1960-talet. Denna förändring kan huvudsakligen tillskrivas den ökade användningen av plaster. När de plaster som numera är vanliga i inredning brinner utsöndras mer rök och toxiska gaser och bränderna uppnår högre temperaturer. Till följd av brandgasernas ökade mängd och giftighet

kan livshotande förhållanden numera uppstå redan efter två till tre minuter. Sammantaget innebär detta att utrymningen kan försvåras och att övertändning kan ske inom fem minuter efter att branden brutit ut.

De intervjuade experterna anser sammanfattningsvis att brandskyddet beror av:

- Individers agerande
- Organisationers agerande
- Sårbarheten hos de personer som exponeras för en brand
- Produkters brandegenskaper
- Det tekniska brandskyddet i byggnaden
- Räddningstjänstens förmåga att hantera en brand

För att få ett bra brandskydd är det lämpligt att alla dessa faktorer hanteras.

Enligt de svenska experterna har många andra EU-länder en mer reglerad bygglagstiftning än Sverige och myndigheterna i andra EU-länder har också större möjlighet att använda sig av sanktioner. I Sverige finns en tradition att försöka få de ansvariga att förstå brandproblemen genom bland annat rådgivning och utbildning.

De två huvudstrategierna för brandskyddet i bostäder är att öka förekomsten av fungerande brandvarnare samt öka kunskaperna om brand genom utbildning och information. Det senare eftersom det mänskliga beteendet bedöms vara den enskilt viktigaste faktorn som påverkar brandskyddet i bostäder. Att brandspridningen mellan bostäder inte får ske inom en timmes tid bedöms av experterna som en strategi som har varit förhållandevis framgångsrik i Sverige.

De senaste decennierna har offentliga byggnader blivit allt större och mer komplexa. Brandcellerna har ökat i storlek och fler människor kan samtidigt vistas i dessa lokaler än tidigare. Den stora faran med bränder i offentliga byggnader är om bränder sprider sig till korridorer, trapphus och andra öppna utrymmen. Detta försvårar utrymningen och möjliggör för branden att sprida sig i byggnaden. Den numera snabba brandutvecklingen innebär att människor många gånger inte inser hur snabbt de måste agera vid brand. Även ansvarsfördelningen mellan de involverade utgör ett problem. Besökarna litar på dem som ansvarar för verksamheten i byggnaden. Samtidigt saknar personal många gånger rätt utbildning för att hantera bränder.

Brandskyddet i offentliga byggnader är beroende av organisatoriska faktorer och byggnadstekniskt brandskydd. Räddningstjänsten bedöms ha större betydelse för livräddning vid bränder i offentliga byggnader jämfört med bostäder. En tidig detektion av en brand är självklart av störst vikt i offentliga byggnader. Utbildning och information är också viktiga för att personalen ska kunna agera i ett tidigt stadium av en brand.

De svenska experterna anser att det är viktigt att kvantifiera den effekt som flamskyddsmedel har för brandskyddet. Flamskyddsmedlen måste sättas i ett större sammanhang tillsammans med andra skyddsåtgärder. Det är också viktigt att öka kunskapen om hur olika flamskyddsmedel verkar. Alternativ till flamskyddsmedel som är skadliga för miljön måste utvecklas. Stöd för beslutsfattande behöver också utvecklas så att olika typer av konsekvenser kan hanteras – fördelarna för brandskyddet måste kunna vägas mot nackdelar för miljön.

Den dominerande orsaken till bränder som leder till dödfall är oaktsamhet vid rökning. Brandskyddet för rökare skulle kunna förbättras om det utvecklades bättre sätt att förhindra att tappade cigaretter orsakade antändningar. Ett sätt är att ställa brandkrav på kläder, madrasser och andra möbler. Ett annat sätt är att uppnå samma mål är att införa krav på cigaretter som inte antänder föremål de faller på. Det har utvecklats cigaretter som är mindre benägna att antända andra föremål. Dessa cigaretter förekommer i andra delar av världen och kan komma visa sig vara mer effektiva och mer lämpliga för att förbättra brandskyddet än en generell ökning av användandet av flamskyddsmedel i kläder och möbler.

Det är tydligt att äldre och människor som är marginaliserade i samhället löper mycket större risk för att omkomma i brand jämfört med resten av befolkningen. Antal äldre förväntas öka kraftigt i framtiden. Det är också möjligt att den ökade konsumtionen av alkohol kan leda till en ökning i antal marginaliserade människor med allvarliga alkoholproblem. Dessa två trender utgör en stor utmaning för brandskyddet i närtid. Därför är det viktigt att utveckla säkrare sätt för dessa riskgrupper att röka samt använda levande ljus och spisar, eftersom dessa brandorsaker står för minst 60 % av alla dödsfall till följd av brand.

1 Introduction

This study of Swedish and Nordic fire statistics was commissioned by the Swedish Chemicals Inspectorate as part of their ongoing work with flame-retardants. The study has been carried out by the National Centre for Learning from Accidents (NCO) at the Swedish Rescue Services Agency (SRSA).

The SRSA is the central supervisory government authority for the rescue services. Its tasks include examining co-ordination between the various branches of the national rescue services, as well as contingency planning by the county administrative boards for the rescue services in the event of a release of radioactive substances. The agency also collates observations and lessons learned from serious emergencies that have occurred at home and abroad. It also develops methods and equipment for use by the rescue services, and is responsible for the training of all personnel in the municipal fire and rescue services and in the chimney sweeping service.

The SRSA is responsible for supervision in four fields: the Civil Protection Act, the Transport of Dangerous Goods Act (the part that covers safety advisers), the Law on Measures to Prevent and Limit the Consequences of Serious Chemical Accidents (Seveso Directive) and the Flammable and Explosive Goods Act.

In 2001 the SRSA were instructed by the government to build up the National Centre for Learning from accidents (NCO) as an arena for cross-sector cooperation and the development of competence for analysing incidents and accidents. The NCO provide an overview and assessment of accident trends and safety work, based on statistics from the various national authorities involved in safety work. Lessons learned from accidents are disseminated in the safety community. The NCO communicate their findings in the form of written reports, workshops, seminars, conferences and via the SRSA homepage (www.raddningsverket.se).

The report has two main parts, a quantitative presentation and analysis of the fire problem as described in Swedish and Nordic statistics and an analysis of fire protection strategies as described by leading Swedish experts.

Fire risks vary in different situations – there is no general fire problem and consequently no universal solution to ensure fire safety. Fire protection strategies for a certain environment should be adapted to the specific aspects of the fire risks in that particular environment. Most fire deaths occur in homes, so home fires were obviously an important area to study. In a normal year few people die in fires in public buildings. However the consequences of a fire in a public building can be very serious, as witnessed in the fire in the Macedonian Association's hall in Gothenburg 1998, when 63 young people lost their lives. It was decided to study these two areas where loss of life is a major consideration in greater detail.

The report begins with a study of fatal fires and their victims. Only a small proportion of all fires have fatal consequences. It is important to study what lies behind these fires – what is special about fatal fires and what should we do differently to improve fire safety? Since 1999 the SRSA have cooperated with local fire brigades to collate information on fatal fires. This material gives a unique insight into fatal fires. Statistics from the health authorities give an insight into the victims and how they were injured, and can be studied over a longer time frame to see if anything has changed over recent decades. A comparison is made with

statistics available from the fire authorities in other Nordic countries, together with statistics from the International Association of Fire and Rescue Services (CTIF).

Fire service and health authority statistics on non-fatal fire injuries are presented in the next chapter.

Having presented the consequences of fires in general, the report goes into more detail on fire in the home. The main source of information for this study is provided by turn-out statistics from the Swedish fire brigades, which have been produced since 1996. The report then goes on to look at Swedish fire brigade statistics on fires in public buildings.

Having provided the reader with a broad description of the general fire problem together with a more detailed presentation of fires in homes and public buildings, it is appropriate to present strategies for fire protection. In order to do this, four leading Swedish experts were interviewed about fire protection strategies in homes and public buildings and the developments observed over recent decades. Two of the experts are internationally well-known professors. The other two experts have long experience from the Swedish fire service and have also played an active role in Swedish fire research.

The report concludes with a discussion of various aspects of fire safety which have come up during the study.

2 Fatal fires and fire deaths

2.1 Fatal fires

2.1.1 Swedish fire authority statistics

Since 1999 the SRSA have cooperated with the municipal fire brigades to follow up any fatal fires that come to their knowledge through fire service turn-outs, newspaper articles etc. The database is a unique source of information on the characteristics of fires in which people are killed. The following four criteria are used to decide whether a fire and one or more victims should be included in the dataset:

- The victims shall have died due to a fire or explosive combustion process
- The deaths must occur within a month of the event
- If a fire occurs as the result of a road accident then it must be clear that the victims were living when flames or fire gases reached the body
- People who are already dead as a result of trauma from road accidents, electricity, illness, hanging or other events are not included, even if the body afterwards was exposed to fire or an explosion

In 2004, 62 fires were recorded according to these criteria, leading to a total of 65 deaths. This was a sharp and unexpected reduction to less than half the number of deaths than in the three previous years. The data series only covers six years, but 2004 would appear to have been an exceptional year. The official cause of death register does not include such a low annual total in the period from 1945 to 2003.

The vast majority of fatal fires lead to only one death. The fires with more than three fatalities recorded in the database are all following road accidents. The table below illustrates how frequent fires with multiple deaths are.

Table 1

Fatal fires by the number of deaths per fire, Sweden, 1999-2004

Source: Fatal fire statistics, Swedish Rescue Services Agency

Number killed in fire	1999	2000	2001	2002	2003	2004	Total number of fires	Proportion of fatal fires
1	97	97	104	118	101	59	576	92,3%
2	1	2	11	7	15	3	39	6,3%
3		2	1	2	1		6	1,0%
4			1				1	0,2%
5	1						1	0,2%
6	1						1	0,2%
Total number of fires	**100**	**101**	**117**	**127**	**117**	**62**	**624**	**100%**

The table below shows the number of fatal fires and fire deaths in different building categories. The majority of fatal fires occur in homes.

Table 2

Number of fatal fires and fire deaths in building fires per building category, Sweden, 2004 and average for 2000-2004

Source: Fatal fire statistics, Swedish Rescue Services Agency

	Number of fires 2004	Number of deaths 2004	Average number of fires 2000-2004	Average number of deaths 2000-2004
Block of flats	22	22	38,0	40,0
Detached house	19	21	37,2	42,6
Terraced/semi detached house	5	5	3,6	3,8
Summer cottage	2	2	4,0	4,4
Care of the elderly	1	1	6,0	6,0
Other public building	2	3	2,4	2,8
Industrial building	1	1	1,2	1,4
Other building	1	1	3,4	3,4
Total	**53**	**56**	**95,8**	**104,4**

A total of nine people died in other fires or explosive combustion processes in 2004. In two cases this was due to fireworks. In two other cases elderly men died when they lost control of fires they had lit in the spring to get rid of last year's dead grass.

Table 3

Number of fatal fires and fire deaths not in buildings per category, Sweden, 2004 and average for 2000-2004

Source: Fatal fire statistics, Swedish Rescue Services Agency

	Number of fires 2004	Number of deaths 2004	Average number of fires 2000-2004	Average number of deaths 2000-2004
Car	3	3	3,6	4,2
Other road vehicle	0	0	0,6	1,4
Ship/boat	0	0	0,2	0,2
Terrain	3	3	1,8	1,8
Other	3	3	2,8	3,4
Total	**9**	**9**	**9,0**	**11,0**

As shown above, the majority of fatal fires occur in the home. It is therefore worth studying these fires in more detail. Three quarters of fatal home fires start in the living room, a bedroom or the kitchen.

Table 4

Number of fatal home fires per room of origin,
Sweden, 2004 and average for 2000-2004

Source: Fatal fire statistics, Swedish Rescue Services Agency

Room of origin	2004	Average 2000-2004
Living room	16	25,2
Bedroom/dormitory	18	20,8
Kitchen	4	14,6
Landing	2	2,2
Boiler room	1	1,0
Freestanding storehouse		1,0
Cellar		0,8
Balcony/patio/outside walkway	2	0,8
Bathroom/toilet/sauna	1	0,6
Laundry room		0,4
Attic		0,4
Out of building		0,4
Store room	1	0,2
Chimney		0,2
Freestanding garage		0,2
Other		2,6
Unknown	3	11,4
Total	**48**	**82,8**

In 70 % of fatal home fires an object of origin is identified – beds are the most common, followed by sofas, other loose fittings, cookers and clothes.

Table 5

Number of fatal home fires per object of origin,
Sweden, 2004 and average for 2000-2004

Source: Fatal fire statistics, Swedish Rescue Services Agency

Object of origin	2004	Average 2000-2004
Bed	11	16,0
Sofa, armchair	8	8,0
Other loose fittings	8	8,0
Cooker	2	6,4
Clothing	1	4,0
Flammable liquid	3	2,4
TV	1	1,8
Other electrical installation		1,6
Heating appliance	2	1,2
Fire place		1,0
Paper/cardboard		0,6
Smoke duct		0,2
Sauna appliance		0,2
Tumble drier		0,2
Coffee maker		0,2
Fridge/freezer		0,2
Stereo/video		0,2
Lamp bulb		0,2
Rubbish		0,2
Curtains		0,2
Other	1	6,4
Unknown	11	23,6
Total	**48**	**82,8**

A fire cause is identified in about 70 % of fatal home fires, with smoking being by far the most common cause.

Table 6

Number of fatal home fires per fire cause, Sweden, 2004 and average for 2000-2004

Source: Fatal fire statistics, Swedish Rescue Services Agency

Fire cause	Number of fires 2004	Average number of fires 2000-2004
Smoking	21	25,2
Heat transfer	1	7,0
Arson	5	6,8
Cooking appliance left on	3	5,8
Candle	3	3,4
Technical fault	0	2,4
Sparks	0	0,6
Explosion	0	0,4
Lightning	0	0,2
Spontaneous combustion	1	0,2
Other	1	4,0
Unknown	13	26,8
Total	**48**	**82,8**

Fatal fires are more common in the winter than in the summer and more common at weekends than on weekdays. Fatal fires are somewhat more common during the night than during the

day, but do not show the marked dip in the late night and early morning as observed in home fires in general.

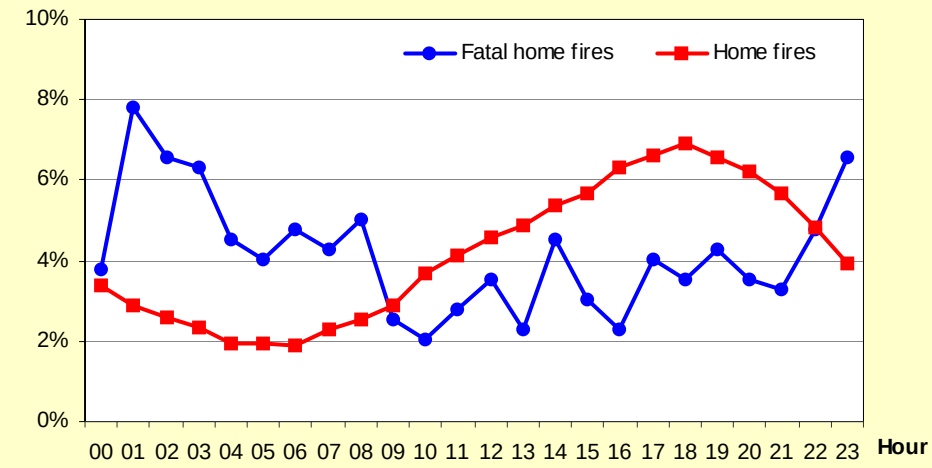


Diagram 1
Distribution of fatal home fires over the day compared to the distribution of all home fires, Sweden, 2000-2004
Source: Fatal fire statistics and turn-out statistics, Swedish Rescue Services Agency

A fire in the home environment can develop rapidly and in a short space of time become life threatening, especially if the people at risk are sleeping. It is clearly important for occupants to be made aware of any fire without delay. Fortunately in recent years domestic smoke detectors have become cheap and readily available. Many fire brigades work actively to promote domestic smoke detectors in the belief that they will reduce fire deaths. It is therefore valuable to investigate smoke detectors' function in fatal fires. Over the last five years the fire investigators have observed the following results:

Table 7
Fatal home fires by smoke detector function, Sweden, 2000-2004
Source: Fatal fire statistics, Swedish Rescue Services Agency

	Proportion of fatal fires
No smoke detector present	61%
Smoke detector present and functioned	14%
Smoke detector present but failed to function	4%
Smoke detector present, function unknown	5%
Unknown whether smoke detector was present	16%

It is striking that such a large proportion of these homes were not protected by smoke detectors. This is in marked contrast to Swedish homes in general - at least 65 % of all homes have smoke detectors (see chapter 5). It is clearly motivated to make efforts to increase smoke detector possession for groups at particular risk. It can be claimed that many of those who died might have been saved by smoke detectors, but it is important to note that in one in seven fatal fires someone dies despite a smoke detector functioning properly.

2.1.2 Nordic fire authority statistics

The central fire authorities in the Nordic countries collate statistics on fatal fires which come to their knowledge through newspaper articles and reports from fire brigades. The results have recently been pooled and are available at the web site www.nordstat.net, hosted by Statistics and Analysis at the Danish Emergency Management Agency.

Table 8

Number of fatal fires and fire deaths in the Nordic countries

Source: Nordic fire authorities at www.nordstat.net

	Denmark		Iceland		Finland		Norway		Sweden	
	Fatalities	Fires	Fatalities	Fires	Fatalities	Fires	Fatalities	Fires	Fatalities	Fires
2004	86	79	3	3	94	88	55	52	65	62
Average 2000-2004	82,2	75,8	3	1	71,8	63,8	59	52	115,4	104,8

As can be seen in the table above, the number of fatalities is not much greater than the number of fatal fires. The vast majority of fatal fires only have a single victim and occur in the home environment. It is relevant to relate the number of fatal home fires to the number of home fires.

Table 9

Fatal home fires, Denmark, Norway and Sweden, 2000-2004

Source: Nordic fire authorities at www.nordstat.net

	Denmark	Norway	Sweden
2004	55	46	48
Average 2000-2004	51,8	45,6	82,8

The Swedish death rate per hundred home fires was low in 2004 due to the low number of deaths that year. We therefore include an average for Sweden over the five-year period 2000-2004. Sweden and Norway have similar numbers of deaths per million population, but Norway has relatively few home fires and therefore a higher death rate per hundred home fires.

Table 10

Fatal home fires per 100 home fires, Denmark, Norway and Sweden, 2000-2004

Source: Turn-out statistics - Nordic fire authorities, fatal fire statistics at www.nordstat.net

Home fires adjusted to exclude chimney and garage fires

	Denmark 2004	Norway 2004	Sweden 2004	Sweden 2000-2004
Fatal fire rate per 100 home fires	1,44	2,96	1,14	1,85

2.2 Fire death statistics

2.2.1 Swedish fire authority statistics

The SRSA cooperate with the municipal fire brigades to follow up any fatal fires that come to their knowledge through fire service turn-outs, newspaper articles etc. The following number of people have died in fires since the collection of data began in 1999.

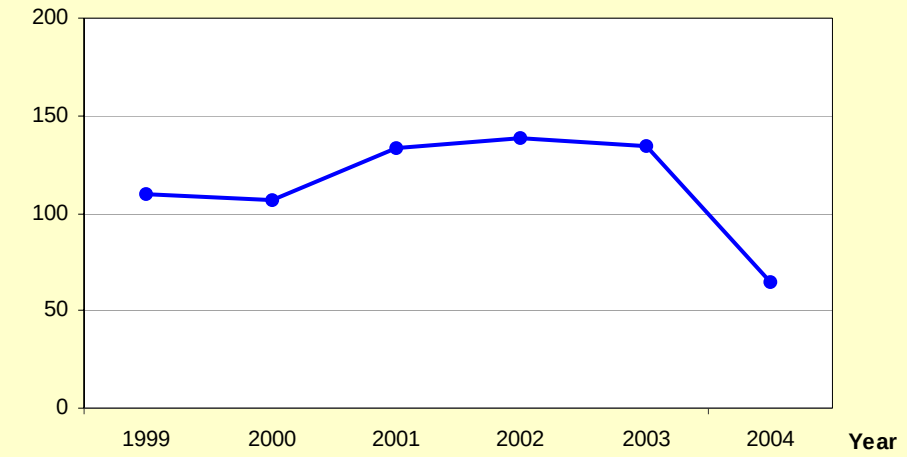


Diagram 2
Number of fire deaths, Sweden, 1999-2004
Source: Turn-out statistics, Swedish Rescue Services Agency

2.2.2 Nordic fire authority statistics

The central fire authorities in the Nordic countries publish statistics on fatal fires at the web site www.nordstat.net, hosted by Statistics and Analysis at the Danish Emergency Management Agency. When comparing different countries it is appropriate to relate the number of deaths to the population of each country. As mentioned earlier, 2004 was an exceptional year as far as Swedish fire deaths were concerned. Sweden's average for the five-year period is very similar to that of Norway, rather more than Iceland and somewhat less than Finland and Denmark.

Table 11
Number of fire deaths and fire deaths per million population in the Nordic countries
Source: Nordic fire authorities at www.nordstat.net, Eurostat

	Denmark	Iceland	Finland	Norway	Sweden
Fire deaths					
2004	86	3	94	55	65
Average 2000-2004	82,2	3	71,8	59	115,4
Fire deaths per million population					
2004	15,93	10,32	18,01	12,02	7,24
Average 2000-2004	15,32	10,50	13,82	13,03	12,95

2.2.3 International fire authority statistics

The International Association of Fire and Rescue Services (CTIF) have a Center of Fire Statistics which produce statistics based on material reported by the national fire authorities. Fire death rates as published in “World Fire Statistics” report number 10, 2005, vary greatly among the 77 countries covered. The eight countries with the highest death rates are all from the former Soviet Union, with rates of 40 to 117 deaths per million population per year. Sweden has 13 deaths per million and is typical of the countries in northern Europe, while Germany, the Netherlands and several southern European countries have death rates from 4 to 7 per million.

We are not aware of any extensive studies which have explained why the differences are so great. It is unlikely that differences in the choice of building materials are a factor, since they are not considered to play an important role in the initial phase of a fire. Fires in furniture and fittings are serious threat to those in the room in question. Flashovers have been known to occur in houses built of stone or concrete, due to the fire load of the contents. Smoking in itself would not seem to explain the differences in death rates either, as smoking is more common in the south than the north. Drinking patterns could perhaps explain some of the difference in fire death rates. In Sweden the marginalised members of society who combine alcohol abuse and smoking have long been recognised as a group at particular risk.

2.2.4 Swedish health authority statistics

The SRSA have only compiled fire death statistics since 1999. In order to study a longer period it is necessary to turn to health authority statistics, which also allow the study of medical diagnoses which have lead to the deaths of the fire victims.

The Centre for Epidemiology (EpC) at the Swedish Board of Health and Welfare maintain a comprehensive cause of death register. For this report we have studied the following external causes: building fire, non-building fire, ignition of clothing, ignition of flammable materials, other or unspecified fire or open smoke. The series covers a number of versions of the international classification standard. It is sometimes difficult to translate the individual causes from one version to another, so we have chosen to study the aggregated figures which allow a good comparison over time.

The total number of deaths for the external causes listed above for the period 1945-2002 is shown in the diagram below. The black line is the linear trend – a gradual reduction in fire deaths over the years.

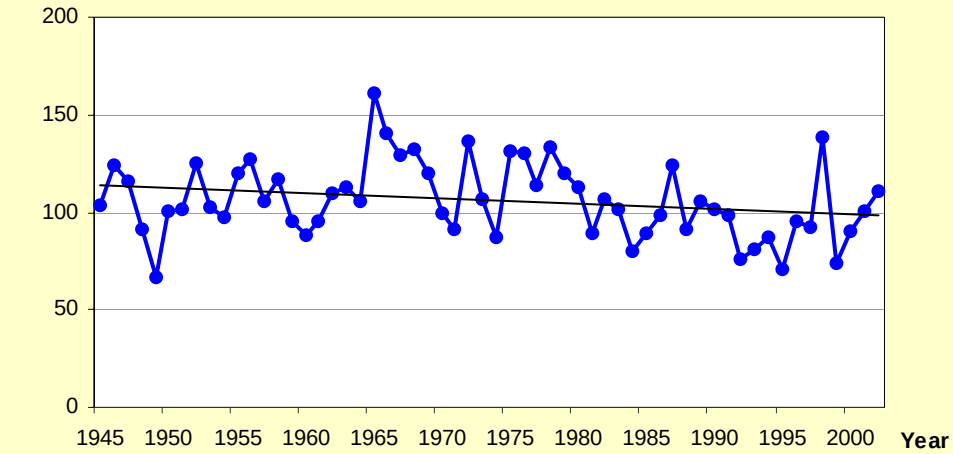


Diagram 3
Number of fire deaths, Sweden, 1945-2002
Source: Cause of death register, Statistics Sweden and Swedish Board of Health and Welfare

However when considering such a long time series it is important to make allowances for population growth. The diagram below shows the number of deaths per million population (pmp). This is equivalent to the risk of dying in a fire, which has decreased by 35 % since 1945.

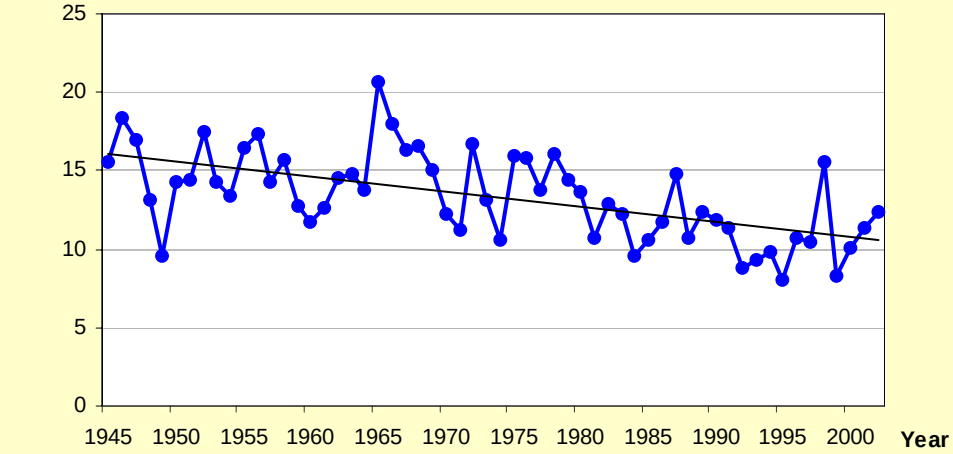


Diagram 4
Fire death rate per million population, Sweden, 1945-2002
Source: Cause of death register, Statistics Sweden and Swedish Board of Health and Welfare

We have also obtained more detailed material from the cause of death register for fire deaths in the period 1969-2002. In the diagram below, the death rate is presented per sex, together with the linear trend. The risk of fire death for men has reduced from more than 20 pmp to about 13 – a 35 % reduction. The trend for women has remained constant throughout the period, at about 7.5 pmp, which is substantially lower than the rate for men.

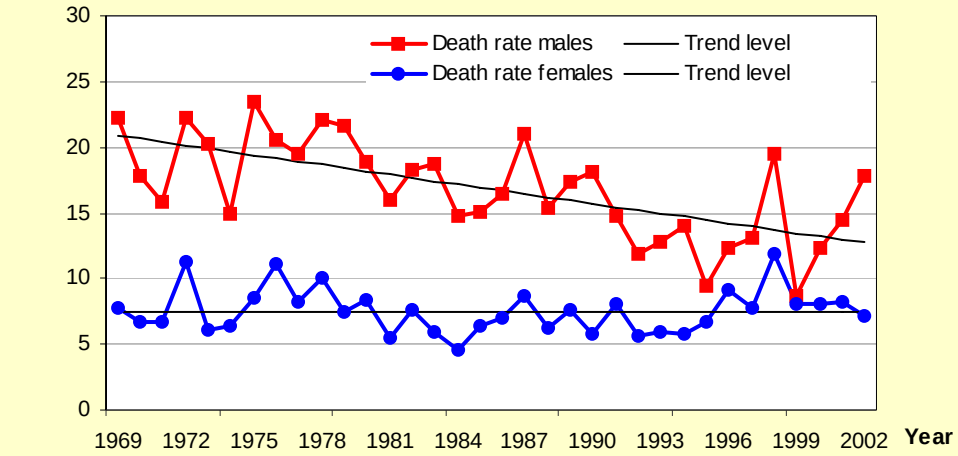


Diagram 5

Fire death rate per million population, by sex, Sweden, 1969-2002

Source: Cause of death register, Swedish Board of Health and Welfare

It is also possible to break the material down by age in order to see the average fire death rates for various age groups for the two sexes. Children have the lowest death rates and pensioners the highest. It is interesting to note that the male age groups have a much higher rate than the corresponding female groups.

Table 12

Fire death rate per million population by age group and sex, Sweden, 1969-2002

Source: Cause of death register, Swedish Board of Health and Welfare

Age group	Male death rate	Female death rate
0-14	4,6	3,3
15-64	15,2	4,6
65+	41,1	21,7

With the help of trend analysis it is also possible to see how the rates have changed over the years. Trends for males and females 0-14, 15-64 and 65 and over were studied. Five of the groups showed no upward or downward trend, but the trend for males 15-64 corresponds to more than a halving of the death rate from 1969 to 2002.

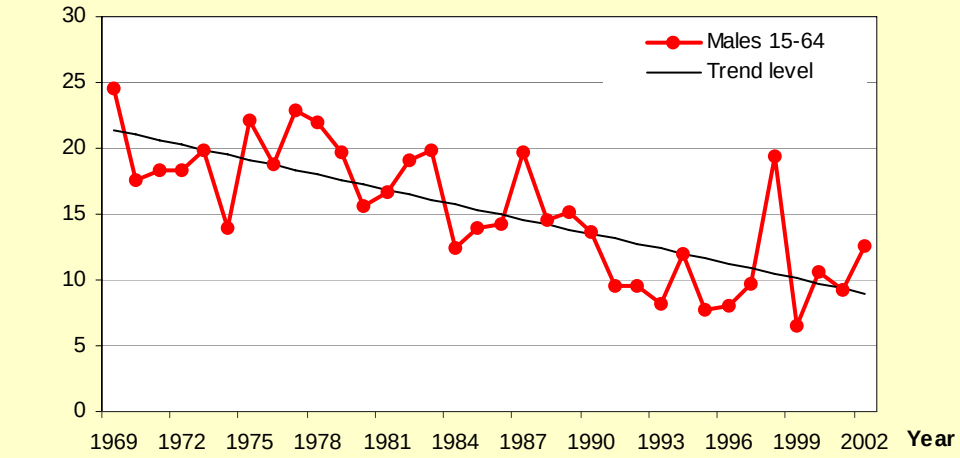


Diagram 6
Fire death rate and trend level per million population for males 15-64, Sweden, 1969-2002
Source: Cause of death register, Swedish Board of Health and Welfare

It would be very interesting to find out what has caused this marked risk reduction. Which changes in environments and behaviour have affected the fire risk? One possible contributory factor which has been observed over this period is the marked reduction in smoking (see section 2.4 below). Smoking is the most commonly identified cause of fatal fires. However further studies must be carried out to quantify the effect that the reduction in smoking has had on fire deaths.

In order to learn more about fire deaths it is important to study the medical diagnosis of what actually led to the death. Fires can cause different kinds of injuries - people can die as a result of burns sustained in a fire, they can be overcome by toxic fire gases or they can die in other ways, for example when throwing themselves out of a high building in an attempt to escape from a fire. The two dominating diagnoses in the cause of death register are ”burns” and ”toxic effects of carbon monoxide”.

Over the period 1969-2002 half the victims have died as a result of burns sustained in fires. The proportions for the different diagnoses are shown in the diagram below.

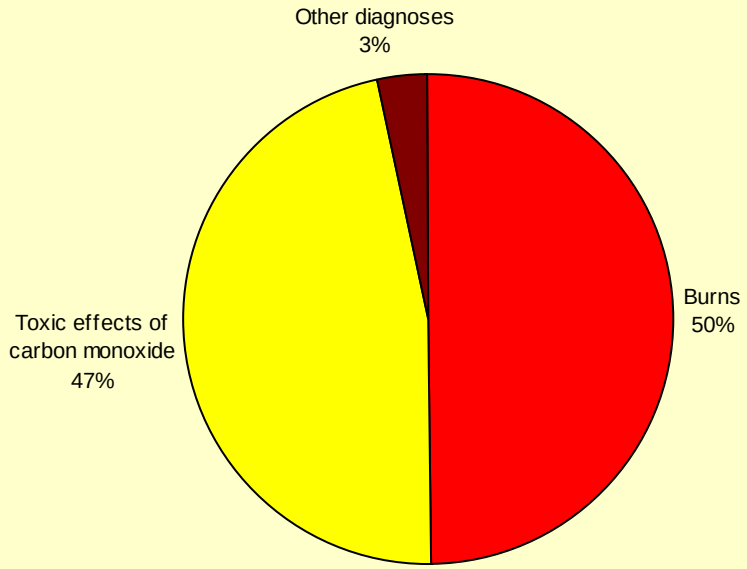


Diagram 7
Medical diagnoses with fire as an external cause of death, Sweden, 1969-2002
Source: Cause of death register, Swedish Board of Health and Welfare

Death rates for these diagnoses fluctuate quite widely from year to year. It is therefore motivated to carry out a trend analysis in an attempt to identify underlying trends in the data. In 1969 burns were at a much higher level than carbon monoxide poisoning. However burns have followed a downward trend during the observed period, unlike carbon monoxide poisoning. The death rate from burns has more or less halved since 1969 and is now at a comparable level with carbon monoxide poisoning.

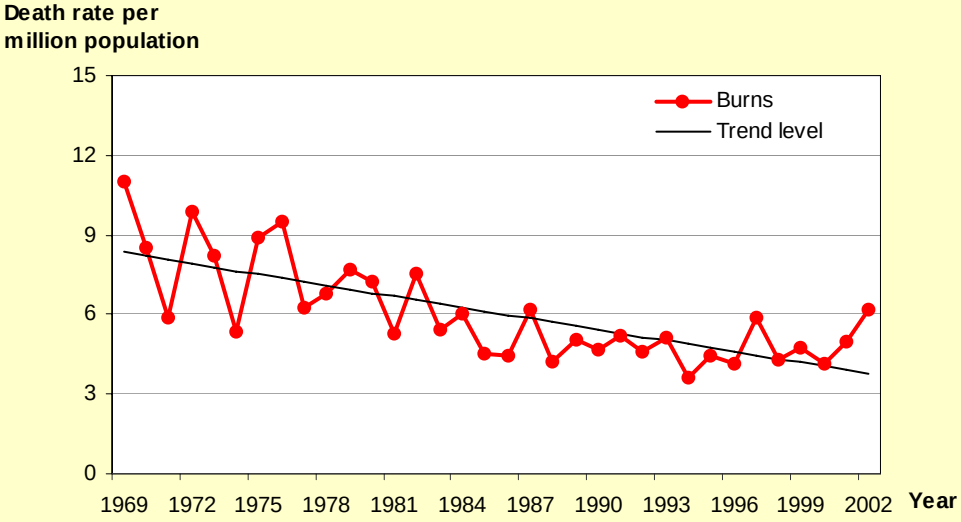


Diagram 8
Death rate for diagnosis burns with fire as external cause, Sweden, 1969-2002
Source: Cause of death register, Swedish Board of Health and Welfare

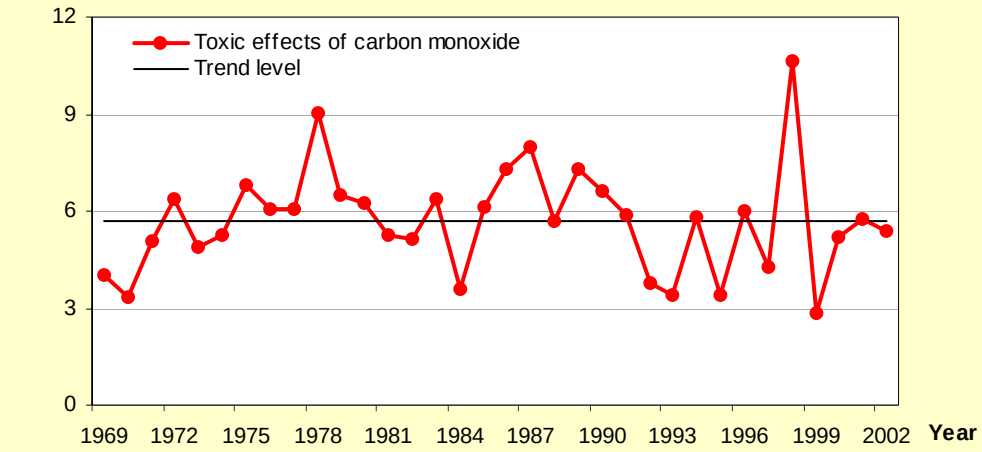


Diagram 9
Death rate for diagnosis toxic effects of carbon monoxide with fire as external cause, Sweden, 1969-2002
Source: Cause of death register, Swedish Board of Health and Welfare

The reduced death rate from burns is attributable to one particular age group - males 15-64 years of age.

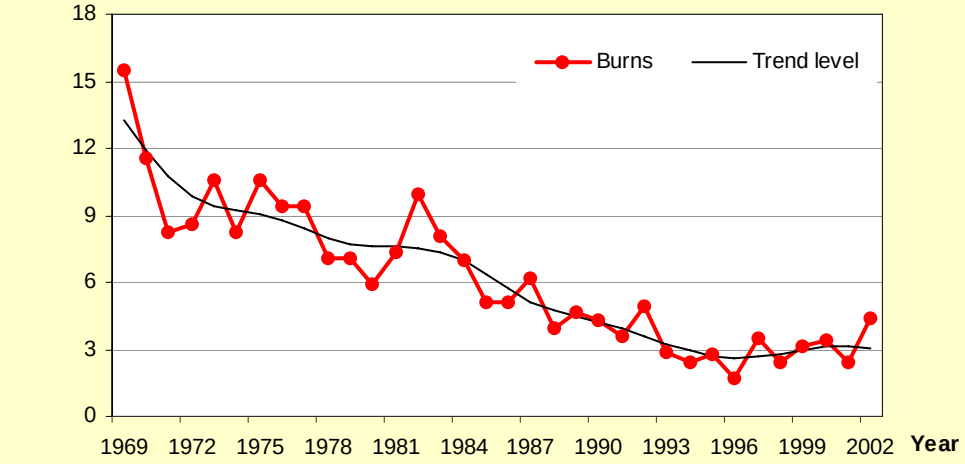


Diagram 10
Death rate for diagnosis burns with fire as an external cause for males 15-64, Sweden, 1969-2002
Source: Cause of death register, Swedish Board of Health and Welfare

It would be very interesting to know why members of this group are no longer at such a high risk of dying from burns. What has changed in their environments? Have behaviour patterns changed for this group? Are the fires they experience of a different character? Are they in more robust health now? Have doctors become more skilful at treating burns for this group? It is clearly impossible to answer these questions just by studying the published statistics. Further study is required to find answers to these questions.

2.3 Socio-economic profile of Swedish fire victims

Jan Schyllander, a researcher at Karlstad University and the National Centre for Learning from Accidents has begun a study of fire victims for the years 1992-2002. Fire victims have been identified in the cause of death register at EpC/Swedish Board of Health and Welfare. Information on these 1242 individuals has then been collected from various registers in Statistics Sweden. It is hoped that this unique material will shed light on health and social factors which influence the risk of dying in a fire. The work is not yet published but it is worth relating the preliminary findings from the research.

During the period 1992 to 2002 a total of 1242 people died in fires. This corresponds to an average of 113 per year, though the variation from year to year is high. The highest value is 168 deaths in 1998, a figure which includes 63 young people who died in the fire in the Macedonian Association's hall in Gothenburg.

Of the total of 1242 deaths, 1016 are classed as accidental, 108 as suicide and 26 as violence or arson. The motive is unclear for 92 of the deaths.

Two thirds of Sweden's population (from 20 to 84 years of age) live as a couple with or without children at home, 30 % live alone and 4 % are single parents with one or more children at home. The proportions are very different for those who died in fires. Three quarters lived alone, while only one in five lived as a couple with or without children and 6 % were single parents with children at home.

The average income from work in Sweden in 2003 was approximately 210 000 SEK/€23 000 for men and 176 000 SEK/€19 000 for women. For those who died in fires the figure was much lower – 37 000SEK/€4 100 for men and 19 000 SEK /€2 100 for women. In the age group 20 – 44 more than 40 % were without an income from work and a further 25 % earned less than 100 000 SEK/€11 000. For the age group 45 – 64 nearly 60 % were without an income from work and a further 15 % earned less than 100 000 SEK/€11 000.

In Sweden as a whole just over 41 % live in flats, 50 % in houses excluding farms, 6 % in farmhouses and 2 % in other forms of accommodation. Of those who died in fires, 55 % lived in flats, 33 % in houses, 9 % in farmhouses and 2 % in other forms of accommodation. In other words people living in flats or farmhouses are over-represented in fire deaths.

If the fire in 1998 in the Macedonian Association's hall in Gothenburg is not included, then the proportion of those who died in fires who were born in other countries is no different to the proportion in the Swedish population as a whole who were born in other countries.

The unemployed would appear to be at a greater risk of dying in fires than the population as a whole. Nearly a quarter (22.4 %) of those who died in fires in the age group 20 – 64 were unemployed or involved in labour market projects. An upper estimate of the average proportion in the Swedish population 20 – 64 years of age who were unemployed or involved in projects during the period 1992-2002 is 9.6 %.

As seen in section 2.2, death rates in fires are higher for males than females and death rates are higher for the elderly than for younger people. It is also clear that those who are out of work, on low income or living alone also run a greater risk of dying in fire.

2.4 Smoking and alcohol consumption in Sweden

In Sweden smoking and being under the influence of alcohol are often given as background factors to fatal fires. It is therefore motivated to study changes in the level of consumption of tobacco and alcohol.

Sweden was the first country to achieve the World Health Organisation's goal concerning smoking - that less than 20 % of the population smoke. Sweden is one of the few countries where more women smoke than men.

The first smoking survey in Sweden was carried out in 1946. At that time 50 % of all men and 9 % of all women smoked. In the next survey in 1963 the corresponding figures were 49 % for men and 23 % for women.

Since 1980 Statistics Sweden have carried out annual smoking surveys. Smoking has decreased steadily in recent decades. In 1980 36 % of all men and 29 % of all women smoked. The most recently published survey (2003) shows that 1.2 million people or 17 % of the population from 16 to 84 years of age smoke (18 % women and 17 % men). The age group 45-64 smokes most. A different survey published in October 2004 by the Swedish Institute of Public Health showed that 14 % of men and 19 % of women aged between 18 and 84 smoked.

Alcohol consumption in Sweden has increased dramatically in the last ten years. According to the Centre for Social Research on Alcohol and Drugs at Stockholm University, SoRAD, the average annual consumption for people of 15 years or older was estimated to be 8.4 litres of pure (100 %) alcohol in 1996. By 2004 the average annual consumption had increased to 10.5 litres. Increased sales from the state-owned monopoly alcohol retail stores were a major factor behind the 25 % increase, but sales in pubs and restaurants together with import by travellers also increased during the period. In 2004 more generous rules were introduced allowing travellers to bring in greater quantities of alcohol from other EU countries without having to pay tax in Sweden.

SoRAD research shows that men drink more than twice as much alcohol as women. Consumption by women has increased most markedly in the 50 – 75 year age group. Alcohol consumption by 15 year olds has decreased in recent years. It is above all an increase in the frequency of drinking that lies behind the increased consumption, though the pattern of heavier drinking at weekends remains. There are clear seasonal variations in alcohol consumption. Consumption and drunkenness are at their highest levels in the summer. The form of alcohol with the highest consumption is wine. Wine consumption has increased, as has the consumption of export strength beer, while the consumption of weaker beer has decreased.

3 Non-fatal fire injuries

3.1 Major injuries

3.1.1 Fire authority statistics

The SRSA produce statistics on fire injuries based on what is recorded in the turn-out report forms by the municipal fire brigades. Fire officers attempt to estimate if injured people need to be treated as inpatients at hospital or if they need medical attention and can then be let home. The reliability of statistics based on fire officer estimates is obviously questionable. It is not straightforward for fire officers to judge what will happen to those who have been injured in a fire, and data protection laws prevent the health authorities from providing other organisations with sensitive information about their patients. The total number of major injuries as estimated by fire officers is much lower than the total in health authority statistics, see below.

Table 13

Number of injured people judged by fire officer to require medical attention as hospital inpatient, 2000-2004

Source: Turn-out statistics, Swedish Rescue Services Agency

	2000	2001	2002	2003	2004	Annual average	Share	Average/1000 fires
Total	101	76	116	96	81	94,0	100%	0,7
Building fire	87	68	101	89	61	81,2	86%	1,5
Non-building fire	14	8	15	7	20	12,8	14%	0,2

3.1.2 Health authority inpatient statistics

The Centre for Epidemiology (EpC) at the Swedish Board of Health and Welfare maintain a comprehensive hospital discharge register based on information collected from the county councils. A patient must be treated as an inpatient in the hospital for at least 24 hours to be included in the register. For this report we have studied the following external causes: building fire, non-building fire, ignition of clothing, ignition of flammable materials, other or unspecified fire or open smoke. The series covers a number of versions of the international classification standard. It is sometimes difficult to translate the individual causes from one version to another, so we have chosen to study the aggregated figures which allow a good comparison over time. In the rare event that an individual has been treated for injuries from two different fires in the same year then only the diagnosis for the first fire is recorded.

The external causes chosen to cover fire are identical to those used in the earlier study of fire deaths. It is interesting to note that inpatient injury rates are approximately seven times higher than fatality rates. The rate of inpatients treated for fire injuries per sex is presented together with trends in the diagrams below. Men show a downward trend in recent years, from twice as high a level as that for women.

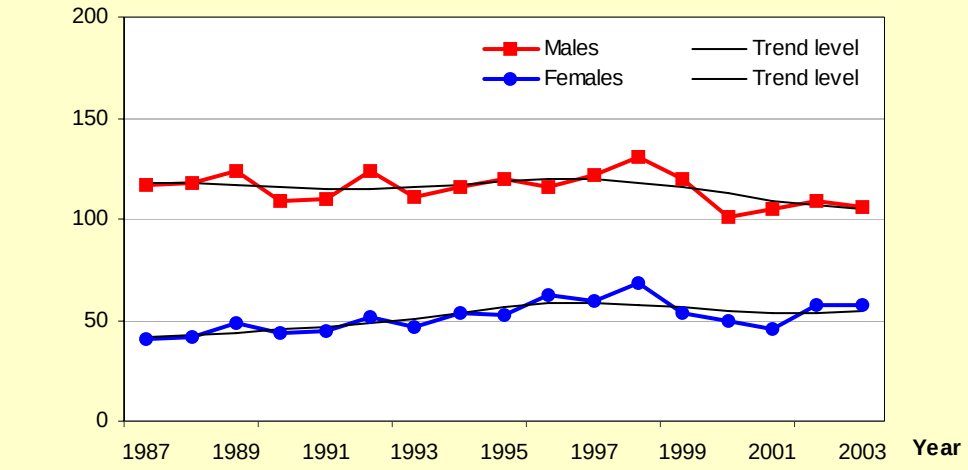


Diagram 11
Fire injury rates by sex, Sweden, 1987-2003
Source: Hospital discharge register, Swedish Board of Health and Welfare

It is interesting to study the main diagnosis for inpatients with injuries sustained as a result of fires. Roughly ten times more patients are treated for burns than for the toxic effects of carbon monoxide (as shown earlier, in recent years death rates from these two diagnoses are at a similar level). It is also interesting to note that the death rate and injury rate for the toxic effects of carbon monoxide are similar. A trend analysis shows that the injury rate for burns has decreased from 1987 while the rate for the toxic effects of carbon monoxide has stayed at a constant level. Other diagnosis increased from 1987 to 1998 but have fallen somewhat since then.

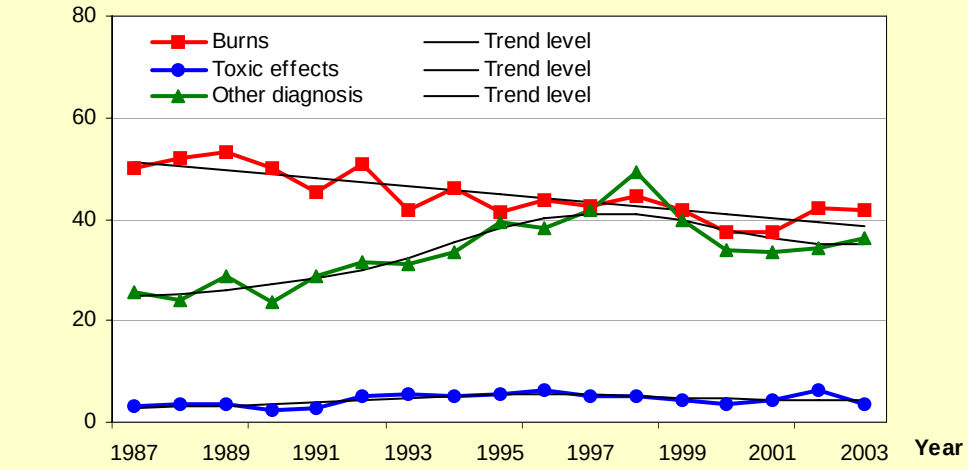


Diagram 12
Fire injury rates by main diagnosis, Sweden, 1987-2003
Source: Hospital discharge register, Swedish Board of Health and Welfare

3.2 Minor injuries

3.2.1 Fire authority statistics

The SRSA produce statistics on fire injuries as recorded in turn-out report forms of the municipal fire brigades (see section 3.1). The total number of minor injuries as estimated by fire officers is at a similar level to the estimate from the health authority statistics, see below.

Table 14

Number of injured people judged by fire officer to require medical attention as outpatient, 2000-2004

Source: Turn-out statistics, Swedish Rescue Services Agency

	2000	2001	2002	2003	2004	Annual average	Share	Average/1000 fires
Total	822	798	877	768	745	802,0	100%	6,1
Building fire	742	731	780	680	650	716,6	89%	13,5
Non-building fire	80	67	97	88	95	85,4	11%	1,1

3.2.2 Health authority statistics

Minor injuries from fire can also be estimated with the help of statistics from the health authorities. Minor injuries are here defined as injuries which call for acute treatment from the health authority but which are not serious enough to require treatment as a hospital inpatient. Sweden joined the European Home and Leisure Accident Surveillance (EHLASS) system in 1995. Introducing the EHLASS in Sweden was a joint responsibility between the EpC/Swedish Board of Health and Welfare and the Swedish Consumer Agency. Four hospitals were selected for participation among those that already had a working accident recording system. Gradually, the system was improved and extended both in number of participating hospitals and also to cover all kinds of injuries (i.e. home and leisure, occupational and traffic accidents, violence). The system covers accident and emergency departments at hospitals and health centres in 27 municipalities. This corresponds to about six percent of the population and Swedish EHLASS data has been used for calculating national injury incidence rates since 1998.

The criteria for this statistical study are that it was a home or leisure accident, that is to say not while at work or in traffic and that fire was the injury mechanism. The period studied was 1998-2003. During this period only 283 visits due to fire injuries were recorded at participating hospitals and health centres. Of all these cases, 45 resulted in treatment as a hospital inpatient so those people will already be included in the analysis in section 3.1 above. These 45 people are therefore excluded in this study, together with one case where age data is missing for the individual concerned. This gives a total of 237 people for our analysis. These observations can be used to estimate the number and rate of minor injuries due to fire on the national level.

Table 15

Estimated number of people per year with minor injuries as a result of fire, Sweden

Source: EHLASS 1998-2003, Swedish Board of Health and Welfare

Age group	Male	Female	Total
0-14	110	10	120
15-64	420	130	550
65+	30	20	50
Total	**560**	**160**	**720**

Table 16

Estimated minor injury rate as a result of fire per million population, Sweden

Source: EHLASS 1998-2003, Swedish Board of Health and Welfare

Age group	Male	Female	Total
0-14	131,9	12,6	73,8
15-64	143,9	46,0	95,7
65+	45,9	22,7	32,6
Total	**127,1**	**35,6**	**80,9**

4 Fire service statistics

4.1 The Swedish fire service

In Sweden the fire and rescue service is a municipal responsibility (with the exception of air, sea and mountain rescue which are provided by central authorities). Many of the 290 Swedish municipalities cooperate with their neighbours in the provision of fire cover. In total there are about 200 brigades with about 730 fire stations. About 150 fire stations have full-time personnel (sometimes with retained firemen as back-up) while 580 stations have only retained firemen. At any time there are about 4000 fire-fighters on duty. This corresponds to about 450 fire-fighters per million population. To provide this cover about 5 800 full-time fire-fighters are employed, together with about 11 000 retained fire-fighters (at the end of 2004 there were 24 full-time and 238 retained women fire-fighters).

The net cost for the municipal fire and rescue service in 2004 was 5 168 million SEK (approximately €450 million).

The time taken by the fire service to attend fires could influence the level of injuries and losses in Sweden. In 2004 the median attendance time for fires in public buildings was 6.1 minutes. Attendance times were somewhat longer for home fires – with a median of 8.0 minutes. This reflects the fact that public buildings and fire stations in general are concentrated in town centres whereas some homes are in remote parts of the municipality. The median time gives only limited insight into how attendance times vary. The diagrams below show the distribution of attendance times for fires in homes and public buildings.

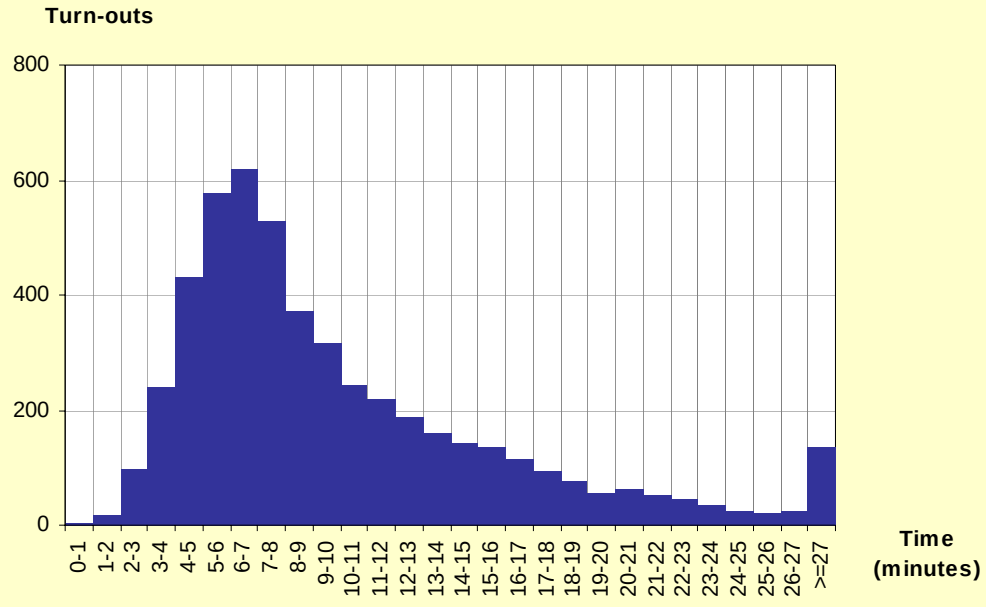


Diagram 13
Fire brigade attendance times to home fires, Sweden, 2004
Source: Turn-out statistics, Swedish Rescue Services Agency

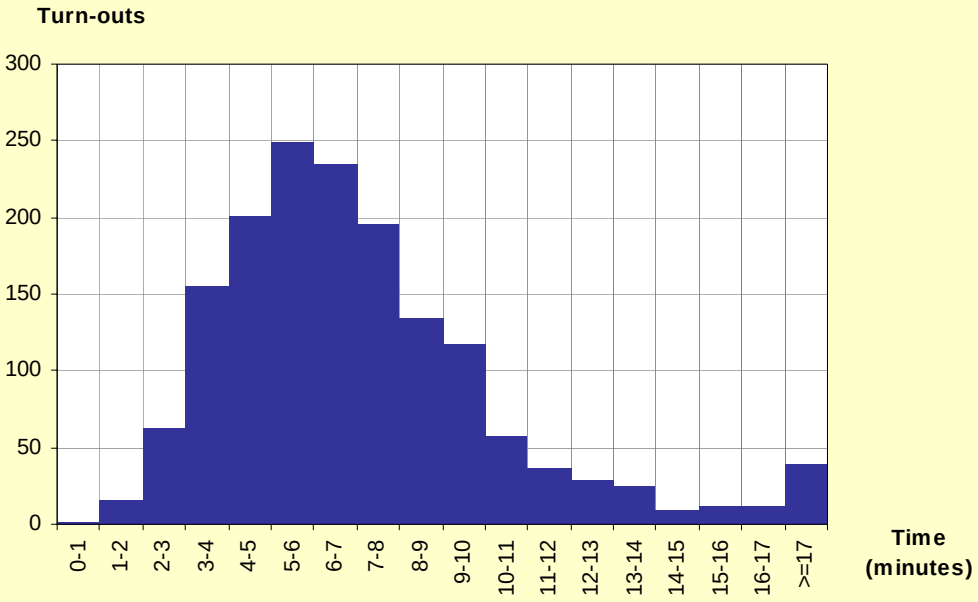


Diagram 14
Fire brigade attendance times to fires in public buildings, Sweden, 2004
Source: Turn-out statistics, Swedish Rescue Services Agency

4.2 Home fires

4.2.1 Characteristics of home fires

In 2004 Swedish fire brigades attended 5 357 home fires. As the diagram shows, there has been a gradual reduction in the number of turn-outs per year. Many of the fires that the fire brigade are called out to are relatively small. Two thirds of these fires do not spread from the object of origin and only one in six spread outside the room of origin.

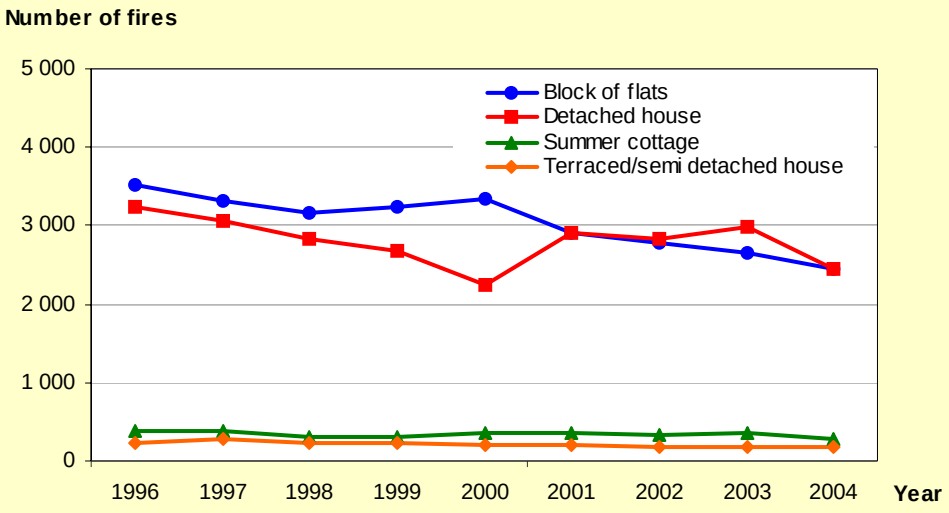


Diagram 15
Number of home fires by house type, Sweden, 1996-2004
Source: Turn-out statistics, Swedish Rescue Services Agency

Fire causes vary somewhat for the different kinds of homes. For detached houses, chimney fires cause two of five fires. Many homes in the forest-covered rural regions are heated by wood and fires sometimes start in the soot deposits in smoke ducts. These fires are rarely serious, only one in ten spread outside the smoke duct. The second most common fire cause in detached houses is a technical fault (9%).

In blocks of flats one in five fires is caused by a cooking appliance being left on. One in seven fires are started deliberately. Arson is rarely directed at living accommodation, most such fires being observed in stairwells, corridors, cellars, attics or rubbish rooms. Technical faults are the third most common fire cause at 7 %.

Technical fault is the second or third most common cause in the four kinds of home fires. It is therefore interesting to see which objects of origin are involved. The table below shows the average number of home fires per year for the most common objects of origin for fires where the cause is given as technical fault.

Table 17

Most common objects of origin in home fires caused by technical faults, average number of home fires per year, Sweden, 1996-2004

Source: Turn-out statistics, Swedish Rescue Services Agency

Object of origin	Average number of home fires with cause technical fault per year
Washing machine	78
Other electrical installation	76
Television	63
Heating appliance	53
Tumble drier	38
Fridge/freezer	35
Dishwasher	29
Fire place	27
Strip light	17
Fan/ventilation	14
Cooker	13

In Sweden there has occasionally been media interest in fires which start in televisions. About 90 % of all fires with a television as the object of origin occur in homes. The diagram below shows a marked reduction in the number of home fires that start in televisions over the last three years, though we cannot say whether this is a permanent change and what has caused it. It should be pointed out that only half of these fires have technical fault as the fire cause. Candles presumably on or beside the TV are given as the cause for 8 % of these fires, and in three of ten fires the cause is unknown.

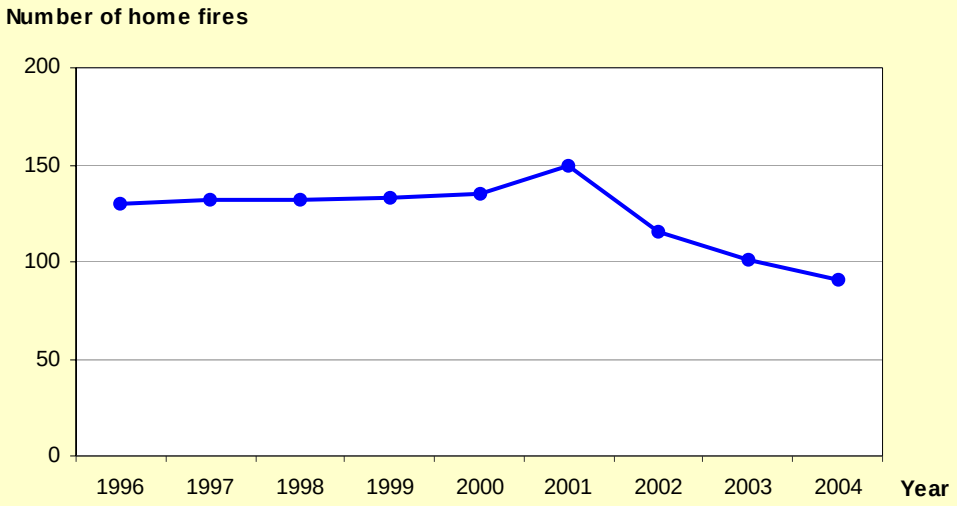


Diagram 16

Home fires with television as object of origin, Sweden, 1996-2004

Source: Turn-out statistics, Swedish Rescue Services Agency

Some seasonal variations are apparent in the fire service statistics. It is not surprising that the fire causes of chimney fire and heat transfer are most common during the winter, peaking in the month of January. Many people light candles in the Christmas period, in accordance with cultural traditions in Sweden. It is not surprising that candles are a major fire cause in the month of December. Two less obvious patterns are the rise in arson in December and January

and the increased rate of fires caused by cooking appliances being left on over the summer months.

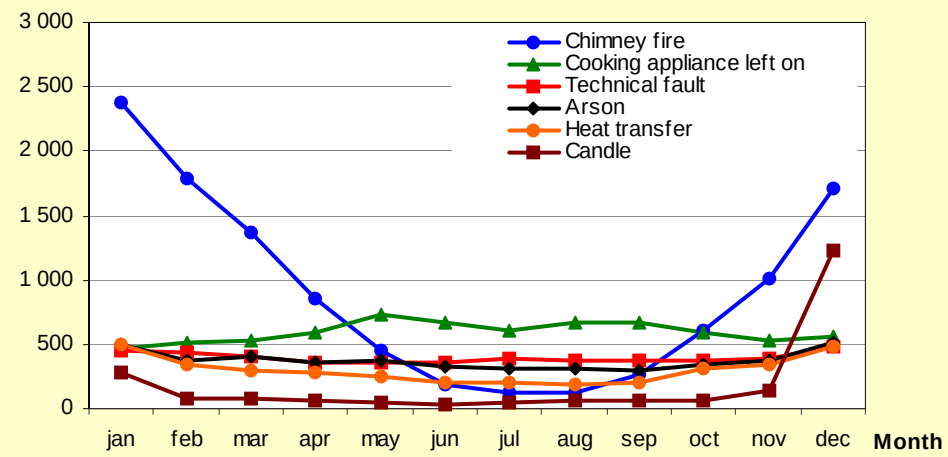


Diagram 17
Seasonal variation for six causes of home fires, Sweden, 1996-2004
Source: Turn-out statistics, Swedish Rescue Services Agency

It is usually relatively easy for people in single occupancy homes to leave the building in the event of a fire (as long as they are aware that a fire has broken out). This is not always the case in blocks of flats. Building regulations stipulate that there should always be two ways out of a building. However some flats are built with access to only one stairwell. Fire should not spread from one flat to another within one hour, and it is assumed that the fire brigade can rescue occupants if the stairwell is blocked by a fire. On average, turntable ladders or hydraulic platforms have been used to rescue people trapped in blocks of flats 20 times per year.

4.2.2 Under-reporting in fire service and insurance statistics

Our two main sources for information on home fires are statistics based on turn-out report forms from the municipal fire brigades and statistics from insurance companies collated by the Swedish Insurance Federation (see appendix 3). How complete a picture of the fire problem in homes do these two sources provide? Many fires take place without the local fire brigade being called or a claim being made to an insurance company. The fire may have been extinguished quickly by someone at the scene or gone out before it was discovered. The property owner may not have bothered to take out insurance cover, or may decide not to make a claim, knowing that the compensation may not be worth the bother as only costs over an excess are paid out.

The SRSA have twice commissioned Statistics Sweden to carry out a questionnaire survey on fires and fire protection in Swedish households. The definition of fire in the survey was: *fire that was not under control and which led to injury or damage.* The studied group was the Swedish population from 18-79 years of age. A questionnaire was sent out to 6 000 people in 1996 and 10 000 people in 2001.

The surveys show that:

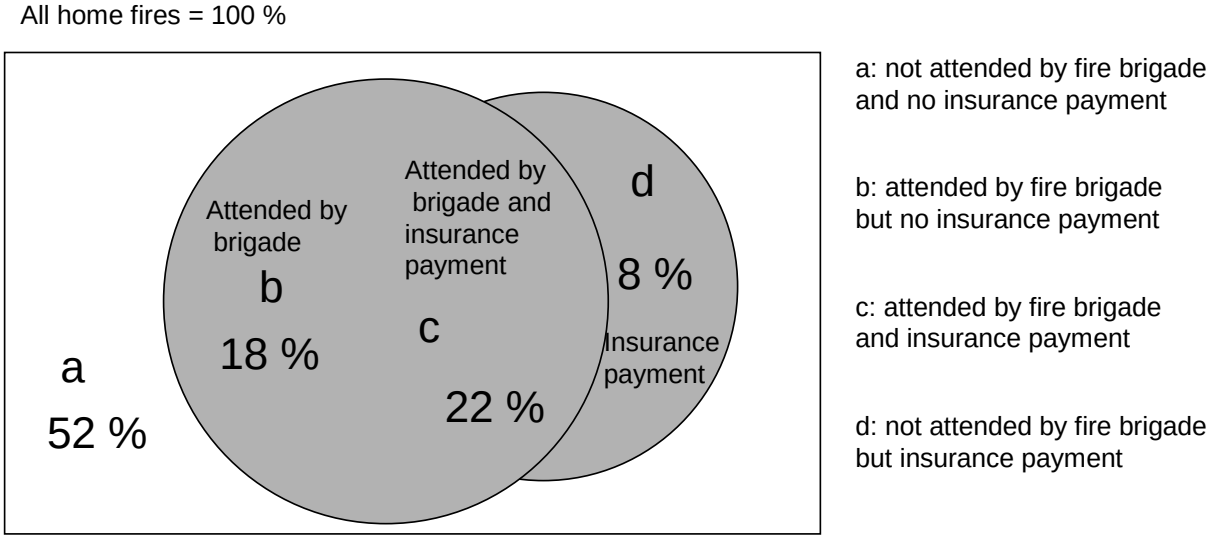
the fire brigade are called to 30-50 % of all home fires,
the household received a payment from an insurance company for 20-40 % of all home fires.

This is important background information when analysing statistics on home fires. A large number of fires are missing in fire brigade or insurance statistics – or both. It is reasonable to assume that it is the more serious fires that are recorded by the fire brigades and insurance companies. It is worth going further to see the proportion of fires that are in neither source, brigade but not insurance, insurance but not brigade or in both sources.

Note that the proportions given below are mid-points of estimates. The confidence intervals are up to 9 %, so the real proportions might be somewhat different from the figures in the diagram. See appendix 1, table 7 for confidence intervals.

Diagram 18

Source: questionnaire survey by Statistics Sweden



All percentages are mid-points of estimates. Confidence intervals are at most +/- 9 %

4.2.3 Nordic comparison of home fires

The table below shows the number of fires attended by the fire brigades in the various Nordic countries. Since chimney fires are common in many rural areas, it is important to adjust the fire brigade statistics so that they are treated in a similar way for all the countries. A majority of the turn-outs to houses in Norway were to chimney fires which damaged neither the chimney or surrounding structures. Such limited chimney fires are not reported individually to the central fire authority and are not presented in detailed statistics. When comparing home fire in the Nordic countries it is relevant to see the incidence in relation to the population. In relation to the number of inhabitants, Denmark has the most home fires and Norway the least.

Table 18

Home fires reported by the fire brigades and home fires per thousand inhabitants, Denmark, Norway and Sweden, 2004

Source: National fire authorities and Eurostat. Figures adjusted to exclude chimney and garage fires

	Denmark	Norway	Sweden
Home fires	4 171	1 622	4 393
Population	5 397 600	4 577 500	8 975 700
Home fires per thousand inhabitants	0,77	0,35	0,49

The Nordic countries may seem similar to each other, but there are significant variations in the housing stocks in the different countries. For example a larger proportion of the Norwegian population live in relatively spacious detached houses when compared with Sweden.

Table 19

Housing stock in the Nordic countries and average floor area per home

Source: Statistical authorities of the Nordic countries,

home floor areas as presented by Aamnes Mostue/Stenstad, SINTEF, Norway

	Denmark	Norway	Sweden
Single occupancy home	1 471 378	1 534 912	2 382 469
Multiple occupancy home	989 377	426 636	1 997 072
Total	**2 460 755**	**1 961 548**	**4 379 541**
Average home floor area	109	117	90

The fire rates for both single and multiple occupancy homes are more or less twice as high in Denmark as in Norway, with Sweden at a slightly higher level than Norway. It would be interesting to study what lies behind this difference.

Table 20

Home fires per 1000 homes, Denmark, Norway and Sweden, 2004

Source: National fire and statistics authorities

	Denmark	Norway	Sweden
Home fires			
Single occupancy homes	2 308	1 168	1 973
Multiple occupancy homes	1 864	454	2 420
All homes	4 172	1 622	4 393
Fire rate per 1000 homes			
Single occupancy homes	1,57	0,76	0,83
Multiple occupancy homes	1,88	1,06	1,21
All homes	1,70	0,83	1,00

4.3 Fires in public buildings

The Swedish fire brigades attend far fewer fires in public buildings than in homes. One characteristic of fires in public buildings is the serious threat that they pose – many people may be in the building and a significant proportion may not be able to find their way around in the building. Another characteristic of fires in public buildings is the prevalence of arson. Fire officers identify arson as the fire cause in a greater proportion of fires attended in public buildings than in other building categories.

Table 21

Average number of fires attended by fire brigade per year by main category and the proportion identified as arson, Sweden, 1996-2004

Source: Turn-out statistics, Swedish Rescue Services Agency

	Total 1996-2004	Average 1996-2004	Total arson	Percentage arson
Home	57 553	6 395	4 483	8%
Public building	16 200	1 800	4 047	25%
Industrial building	11 728	1 303	284	2%
Other	15 703	1 745	2 175	14%
All buildings	**101 184**	**11 243**	**10 989**	**11%**

The category “public building” in the Swedish fire service statistics comprises many different kinds of building. Fire incidence varies between the different types of buildings, as do the most common fire causes. In the table below the average number of turn-outs and the three most commonly identified fire causes are presented for the different building types.

Table 22

Average number of fires in public buildings attended by fire brigade per year and most commonly identified fire causes, Sweden, 1996-2004

Source: Turn-out statistics, Swedish Rescue Services Agency

		Most common causes					
	Number	Cause	%	Cause	%	Cause	%
School	335	Arson	43	Technical fault	9	Child playing with fire	6
Care of the elderly	260	Cooking appliance left on	25	Smoking	13	Technical fault	11
Shop	230	Technical fault	21	Arson	19	Heat transfer	7
Other care centre	139	Cooking appliance left on	26	Arson	18	Technical fault	11
Office	135	Technical fault	21	Arson	12	Cooking appliance left on	9
Restaurant/nightclub	131	Arson	18	Technical fault	15	Heat transfer	8
Hospital	110	Arson	37	Technical fault	19	Smoking	5
Hotel/guest house	83	Technical fault	17	Heat transfer	10	Candle	8
Sport	69	Arson	26	Technical fault	14	Heat transfer	9
Mental care	64	Arson	59	Smoking	10	Cooking appliance left on	5
Nursery school	50	Arson	34	Technical fault	15	Cooking appliance left on	7
Theatre/cinema/museum	44	Arson	16	Technical fault	16	Cooking appliance left on	8
Youth club	34	Arson	28	Technical fault	11	Heat transfer	7
Transport/communications building	33	Arson	22	Technical fault	15	Heat transfer	6
Prison	31	Arson	61	Smoking	8	Technical fault	3
Church etc	27	Arson	24	Technical fault	17	Heat transfer	7
Student hall	21	Arson	26	Cooking appliance left on	12	Candle	11
Defence building	6	Technical fault	24	Arson	9	Heat transfer	5
All public buildings	**1800**	**Arson**	**25**	**Technical fault**	**14**	**Cooking appliance left on**	**10**

In one in seven fires in public buildings the fire officer identifies the cause as a technical fault. The two most common objects of origin for fires caused by technical faults are “other electrical installation” (60 per year) and “strip light” (40 per year).

Often when fires occur in public buildings, people in the buildings leave on their own, or are helped out by people who work there. Occasionally however the fire brigade have to save people who are still in the building when the fire brigade arrive. Firemen wearing breathing apparatus help people out from public buildings on average about 13 times per year, five times with the help of temporary protective masks for the victims.

5 Fire protection measures taken by homeowners

There are many ways for a safety-conscious homeowner to improve fire safety. Electrical items can be repaired or replaced immediately when faults are discovered. The last person going to bed or leaving the house can go round to check that everything is switched off and safe to leave. The owner can install one or more smoke detectors to warn if a fire should break out. A hand-held fire extinguisher or long hose can be placed in a strategic place in the home. The various members of the household can go through what they all should do in the event of a fire breaking out.

A fire in the home environment can develop rapidly and in a short space of time become life threatening, especially if the people at risk are sleeping. Domestic smoke detectors improve fire safety by making occupants aware of a fire before the situation is dangerous.

When considering fire safety in Swedish homes it is clearly important to know how widespread smoke detectors are and how well they function. Domestic smoke detectors were first introduced in Sweden in 1973. They are not manufactured in Sweden, but import statistics give a good idea of how many are sold. Annual imports rose to about 700 000 per year in 1999, and over 1 300 000 were imported in 2002 when municipal fire brigades were promoting their use and the SRSA published advice that every home should have at least one smoke detector. Import statistics do not give a very clear picture of how widespread they are in homes. In order to get an idea of this home surveys must be carried out.

We have studied three series of surveys which include domestic smoke detectors. Each investigation uses a different method to obtain data, different age groups are surveyed and the questions asked are not identical. The different surveys are not directly comparable, but they do complement each other and together give a fairly good picture of smoke detectors in Sweden.

Living conditions survey, Statistics Sweden

Statistics Sweden have carried out a yearly survey on living conditions since 1974. They cover the whole population from 16 to 84 years of age. The sample size is 7 500 and information is obtained through interviews at home. The survey 2000/2001 took up ”security and safety” and included questions on smoke detectors. 75 % of those questioned said that they had at least one functioning smoke detector (Offer för våld och egendomsbrott 1978–2002, Statistics Sweden).

Insurance company surveys

Surveys have been carried out by the Länsförsäkringar insurance company every year since 2001. The national survey is based on telephone interviews of 3 000 people aged between 16 and 69.

Table 23

Fire protection in the home, Sweden, 2001-2004

Source: Länsundersökningen – telephone survey, Länsförsäkringar

	2001	2002	2003	2004
Domestic smoke detector installed	83%	84%	89%	92%
Hand-held fire extinguisher in the home	42%	36%	36%	41%

Swedish Rescue Services Agency surveys
The SRSA have twice commissioned Statistics Sweden to carry out a questionnaire survey on fire and fire protection in Swedish households. The studied group was the Swedish population from 18-79 years of age. A questionnaire was sent out to 6 000 people in 1996 and 10 000 people in 2001.

The proportion of households with smoke detectors has increased from 1996 to 2001. Three of four households checked their smoke detectors regularly, which was a reduction from 1996. Of those who checked them, the proportion that did so at least once a month had dropped. In the questionnaire respondents were asked to check if their smoke detectors were working. In both surveys nearly 90 % said that their detectors were working. This would mean that about 65 % of households had functional smoke detectors in 2001. Three of ten households have hand-held fire extinguishers. Four of ten are without any equipment to put out fires.

Table 24
Fire protection in the home, Sweden, 1996 and 2001
Source: Questionnaire survey by Statistics Sweden for Swedish Rescue Services Agency

	1996	2001
Domestic smoke detector installed	68%	76%
Domestic smoke detector functional	59%	65%
Hand-held fire extinguisher in the home	29%	29%

Various groups have differing levels of fire protection. Those who live alone are less likely to have smoke detectors or fire extinguishers. Immigrants are under-represented in the group having smoke detectors. People in single occupancy homes are more likely to have smoke detectors or fire extinguishers than those in multiple occupancy homes.

The survey results were matched with data from Statistics Sweden on the respondent's income. This is not exactly the same thing as the household's income, but the two are related. Less well-off individuals are less likely to live in households with smoke detectors or fire extinguishers. This background factor could explain all the other observations in the survey results in the above paragraph.

6 Swedish strategies for fire protection in homes and public buildings

A series of telephone interviews were carried out with leading Swedish fire safety experts in order to get a picture of the various strategies for fire protection used in Sweden. The following people were interviewed between 15th and 25th August 2005:

Björn Albinson, Fire Protection Engineer, Emergency Prevention Department, Swedish Rescue Services Agency

Göran Holmstedt, Professor, Fire Safety Engineering Department, Lund University

Göran Schnell, Managing Director, Swedish Fire Protection Association

Ulf Wickström, Professor, Department of Fire Technology, Swedish National Testing & Research Institute

(see appendix 5 for a full presentation).

This chapter is a synthesis of the series of interviews carried out. The answers from the four interviews are combined in order to provide an overview of how the experts assess that fires and fire protection have developed over recent years in Sweden, giving their views on different strategies for fire safety in homes and public buildings.

6.1 Developments in fire growth rates over recent decades

Observations from fire fighting operations and experiments indicate that fires now develop much more rapidly. The interviewed experts were all of this opinion and they assess that this change is mainly because of the increased use of plastics. They observe that plastics have replaced natural materials in loose fittings and other products, both in the home and in public buildings. Plastics have completely different fire characteristics when compared with natural materials – they give rise to a much more rapid fire development, and they produce more smoke and toxic fumes. It now can take only two to three minutes for potentially fatal conditions to occur due to the increased amounts and toxicity of the smoke. This makes it more difficult to escape from a fire and a flashover can occur within five minutes of a fire start. Fires also reach higher temperatures than before. Flashover was quite a rare event in the 1960s. Although flashovers are still rare, they now occur more frequently than before. Also smoke gas explosions, which were extremely rare before, have become more common.

Thin and elegant designs are achieved through the use of lighter and cheaper materials (mainly polymers) which give more easily ignited furniture and fittings. The rapid rate at which new materials are developed makes it harder to keep up with testing how they behave in fires.

A contrary and positive trend seen by the experts is the return to natural materials, which hopefully will give reduced rates of fire growth. Another is that flame retardants with less environmental impact are being developed. In the future these could reduce the flammability of plastic products. One more factor that could be positive for fire safety is the expected increase in the price of oil, which will make plastics more expensive. This increases the

incentive to mix the plastic with powdered wood, clay or other cheap material, which can improve a plastic's fire behaviour.

6.2 Fire protection in general

What is meant with fire protection can vary somewhat depending on context, but usually it covers all the measures taken to protect people and property from fire. Fire protection can work at different system levels, for example in an individual product or in a whole system of buildings and people.

Fire protection measures can be taken before or after a fire breaks out. Relatively few of the activities before a fire takes place are to prevent a fire occurring (for example by removing ignition risks or educating people to be more fire-aware). Most fire protection before a fire is aimed at limiting the damage that a potential fire could cause (for example sectioning, sprinkler, automatic alarms, flame retardants and training personnel in how to respond to a fire). The operative capacity of the fire brigade is also an example of fire protection with a damage-mitigating role.

Fire protection for buildings is often divided into passive and active protection. Passive protection is built into the structure (for example fire walls, encased load-bearing structures). Active protection only operates when a fire has started (for example sprinkler systems, automatic fire alarms).

The term fire safety is related to fire protection. Fire safety is considered to be dependent on:

- How individuals behave
- How organisations behave
- The vulnerability of the people exposed to the fire
- The fire properties of products
- The technical fire safety in the building
- The fire brigade's ability to respond to a fire

If all these points are covered then fire safety can be maintained at a high level. It is not enough just to focus on any one of these points.

The state often demand that fire protection requirements are tougher when weaker groups or individuals are involved who cannot be expected to understand what to do. These systems must be ”forgiving” and compensate for increased vulnerability.

6.2.1 Changes in fire protection over recent decades

One clear development observed by the experts is the more frequent use of various types of fire detection, particularly in the home. The development of domestic smoke detectors took place mainly in the USA, where they became obligatory due to the perception that too many people were dying in fires. Smoke detectors are now a natural part of fire protection in the home.

Sprinkler systems are often large and expensive, though simpler and cheaper systems for residential sprinklers have been introduced in recent years. Sprinklers are not as common in

Sweden as in many other countries, but it would appear that their use is increasing in certain kinds of buildings.

The fire brigades are also undergoing changes. Over recent years we have seen a small reduction in the number of fire-fighters on duty and some fire stations have been closed. However at the same time more effective fire-fighting equipment has been introduced.

The experts judge that three developments have led to greater demands being placed on those responsible for a building project or running activities in a building:

- Performance-based building laws
- Self-auditing under the new Civil Protection Act
- New international methods for testing the fire properties of products

These developments have led to a decentralisation of the judgement of safety levels from the state to individuals responsible for a building project or running activities in a building. It is feared that this means that no one now has an overall picture of how fire safety is changing in society.

Building law fire regulations for technical design used to be expressed in terms of detailed requirements. Those responsible for a building project did not need to have a deep understanding of the effects of various fire protection measures and how they worked together. There has now been a transition to functional requirements where the builder is responsible for ensuring a satisfactory level of fire protection. This places demands on the architect and builder to understand how design affects fire protection (performance-based-design).

The local fire authorities have changed the way they carry out inspections of fire protection. The new Civil Protection Act led to a transition to self-auditing for most public buildings. Traditional inspections are now focused on especially hazardous buildings and buildings where the fire brigade suspect that not enough is being done to ensure fire safety.

Fire testing has gone from a national system based on expert judgements, to an international system of laws and standards. Products which live up to tests prescribed by a standard are put into systems which are operated by people without much knowledge of fire protection. Judgements have been decentralised.

6.2.2 Comparison with fire protection in other European countries

The Swedish experts consider that many other EU countries have more regulated building laws compared to Sweden, and that the authorities in other EU countries have greater opportunities to impose sanctions. Sweden has a tradition of trying to make those responsible for activities in a building understand the fire problem through advice and education. The Swedish authorities do not have control over what is put in buildings. The Swedish system relies more on functional optimisation of fire protection from a technical and economic perspective (especially for large buildings).

6.3 Home fires

The interviewed experts assess that the majority of home fires are caused by carelessness or negligence when handling potential sources of ignition such as cigarettes, candles or cooking appliances etc. Another group of fires are considered to be caused by faults in the electrical system and overheating or other technical faults in electrical appliances. In the home environment there are large quantities of inflammable material such as soft furniture and other loose fittings that can burn when they come into contact with a source of energy. Fires most often start in the contents of a house.

The time taken to discover a fire varies greatly. Once a fire has started to burn with an open flame then it will grow rapidly. If a fire gets established in a sofa or easy chair then it can develop violently and lead to a flashover within three to five minutes. The rapid fire growth and short times to flashover are judged to be due to the quantity of flammable material in a home. The rapid rate of fire growth means that sometimes a flashover has already taken place when the fire brigade arrive at the scene of the fire. It is relatively rare for the fire brigade to be able to prevent the fire from spreading within the flat where it started.

A hundred years ago the fire brigades had special groups of personnel who were responsible for salvaging belongings from burning buildings. They could operate because they knew they had 15-20 minutes in which to take out possessions. Photographs from the 1950s and 1960s show belongings placed in the garden at a safe distance from burning buildings. This is almost never seen nowadays.

6.3.1 Strategies for fire protection in homes

Two main strategies are increasing the coverage of smoke detectors and increasing fire awareness through information and education. The SRSA and the Swedish Fire Protection Association are working together with others to promote these strategies. In addition, it is judged to be important to increase the possession of hand-held fire extinguishers.

One Swedish strategy which the experts judge to have been relatively successful is the containment of a fire within the fire compartment of origin. For many years the regulations have stipulated that a fire in one flat should not spread to a neighbouring flat within less than 60 minutes. This is achieved by building techniques (firewalls and fire doors to the stairwell) together with the tactics of the fire brigade.

A strategy which will probably be more important in the future is improving the protection for certain identified risk groups.

6.3.2 The importance of various factors for fire protection in homes

Those interviewed were asked to discuss and evaluate the importance of six factors: behaviour, psychosocial factors, product design, structural design, the individual’s ability to respond to fire and the fire brigade’s ability to respond to fire.

Behaviour and psychosocial factors
All four experts said that the behaviour of the people in the home was the most important factor for fire protection. Psychosocial factors are also deemed to be important and closely related to behaviour. Swedish studies show that the possession of smoke detectors is related to social status.

Product design
Fires in products with a high fire load or where energy is supplied in the form of electricity are not unimportant, but do not play such a decisive role as behaviour. However products can be designed to cope with careless or incorrect use. They can also be designed not to contribute to a fire in their surroundings.

Structural design
Room surface materials are not seen to have an influence in the start of a fire. The design of a home can play a role later in the development of a fire, in particular concerning the strategy in blocks of flats to contain the fire in the initial fire compartment.

Individual's ability to respond to fires
The ability of occupants to respond to fires is related to behaviour and psychosocial factors. There is often an opportunity to put a fire out if the person who discovers the fire knows what to do.

Fire brigade's ability to respond to fires
Building regulations for blocks of flats are based on the assumption that the fire brigade shall respond within a certain time and that those in danger can escape via their turntable ladders. The fire brigade play an important role together with the technical protection to contain the fire in the initial fire compartment. However the fire brigade only play a minor role in life saving in the initial fire compartment. Fires there have many times reached critical conditions before the fire brigade arrive.

6.3.3 Measures to improve fire protection in homes

The four experts were asked to discuss different measures to improve fire protection in homes and appraise their significance in preventing fires from starting, in dealing with fires in the initial stage of development and to limit the fire consequences.

The most effective measures to prevent fires from starting
Information and education are deemed to be the most important measures. Increased awareness of fire should affect behaviour and lead to greater care.

Other important measures are to reduce smoking and to see that products live up to requirements on ignition (upholstered furniture) and electrical safety (electrical appliances). It is important to be able to identify dangerous products through turn-out statistics and fire investigations, and to remove such products from the market.

The most effective measures to deal with fires in the initial stage of development
In homes early detection by smoke detectors is the most important measure. It is of course important that action is taken once the fire is discovered - people should own fire extinguishers and be trained to handle them. However few homes have a fire extinguisher, so many fires which could have been put out easily with a fire extinguisher are left to take hold of the building.

The most effective measures to limit consequences of fires
Also here smoke detectors are seen as the most cost-effective measure. People should be trained to alert or save people in the building and then if possible put the fire out. The choice

of materials and a continuation of the strategy of each home being a separate fire compartment are also considered important.

Alternative strategies for fire protection
The existing strategies are quite effective, but more should be done to inform and educate people. Education and training for school children is considered especially effective in raising fire awareness across the whole population. Such education should be an obligatory part of all schooling. Television is another medium which should be used more to spread information on fire protection.

It should be possible to improve the fire properties of the plastic products which are the biggest contributors to the fire load in homes. However this is difficult to achieve with national regulations. One possible way to improve matters could be to inform consumers of the fire properties of products with safety labelling.

Some people call for an increase in the use of residential sprinklers.

6.4 Fires in public buildings

According to the interviewed experts, the heat and smoke development is generally just as rapid in public buildings as in the home environment. However there are many more variables that affect how a fire develops in a public building, for example sprinklers, automatic fire alarms and regulations for loose fittings. If everything is as it should be then the occupant of the building works systematically with fire protection, so fire safety is more likely to be dealt with in an orderly manner than in a home.

Over recent decades public buildings have become larger and more complex. Fire compartments have increased greatly in size and more people can be taken in than before. The great danger with fires in public buildings is if fire gases spread to corridors, stairwells and other open spaces. This makes evacuation more difficult and allows the fire to spread to other parts of the building.

The rapid rate at which fires develop means that people often fail to realise how quickly they must respond to a fire. The division of responsibility among those involved is also a problem. Visitors rely on those responsible for the activities in the building. However personnel in a building often lack proper training in how to deal with a fire.

The way a fire situation develops is dependent on when it is discovered, which is influenced by when in the day it occurs. This is especially true of arson attacks, the consequences of which vary greatly according to whether or not the building is in use.

The most serious fires in public buildings often begin in a concealed space, for example a cleaner’s storeroom, rather than in a part of the building being used by people. The fire protection in such spaces is often relatively weak and the initial fire can often grow without hinder and spread to neighbouring spaces. When the fire breaks through to a larger space or is discovered, it is no longer a small initial fire. It has already developed and can take people in the building by surprise and prove difficult to deal with.

Room height is another important factor in how fires in public buildings develop. When flames reach the ceiling they then spread out and increase the heat-radiating area. The effect

necessary for flames to reach the ceiling increases more than linearly with height. Therefore a fire must be considerable size for the flames to reach the ceiling in a high room. The risk of a flashover is therefore relatively small in a room with a high ceiling.

6.4.1 Strategies for fire protection in public buildings

Fire protection in public buildings is dependent on organisational factors and technical measures. Some experts point out that an increased use of engineering analysis for the appropriate level of fire protection can lead to a reduction in safety margins. Knowledge of fire in very large buildings is limited, as is the impact of the various kinds of contents in large buildings and the problems when large numbers of people must escape from a fire. The main strategy in the building laws is to ensure that people can escape before they are exposed to critical conditions. The second strategy is to ensure the safety of fire-fighters. Protecting property is the third priority.

The fire brigade play a more important role for life saving in public buildings than in the home.

6.4.2 The importance of various factors for fire protection in public buildings

Those interviewed were asked to discuss and evaluate the importance of six factors: behaviour, psychosocial factors, product design, structural design, the individual's ability to respond to fire and the fire brigade's ability to respond to fire.

Behaviour and psychosocial factors
The behaviour of people in a public building is seen to be important, but not as important as in the home, since those responsible for the activities in the building must uphold fire safety there. Some experts pointed out that psychosocial factors influence arson.

Product design
The design and choice of material in furniture and other fittings have an impact on fire protection, in particular concerning the function of escape routes. It is important that fire spread and smoke production is limited to enable a safe escape. The contents of a building may well behave in a predictable way with normal technical fire causes, but differently when the fire is deliberately set.

Structural design
Technical fire protection is judged to be more important in public buildings than in homes. If many people must get out of a complicated building then it is important that the structure remains sound until everyone has got out. It is important to ensure that inner ceilings and other fittings do not fall down as a result of the fire during the evacuation and the rescue operation carried out by the fire brigade.

Individual's ability to respond to fires
It is important that employees in the building know what to do and are able to respond to fires. It would seem that safety margins are getting smaller, so this will be increasingly important in the future.

Fire brigade's ability to respond to fires

The response of the fire brigade is judged to be much more important in public buildings than in homes. In public buildings the fire brigade can make the difference between a limited event and a fire disaster.

6.4.3 Measures to improve fire protection in public buildings

The four experts were asked to discuss different measures to improve fire protection in public buildings and appraise their significance in preventing fires from starting, in dealing with fires in the initial stage of development and in limiting the consequences.

The most effective measures to prevent fires from starting
As for homes, education is the most effective measure to prevent fires in public buildings. This is important for the general public, but even more essential for personnel. Both employees and company leaders need to understand fire risks. Other important measures are systematic self-auditing of fire prevention work. It is important to make it difficult for arsonists to target the building and to check fire prevention in concealed spaces in the building.

The most effective measures to deal with fires in the initial stage of development
The early detection of any fire is clearly vital in public buildings. Education and information are also important so that personnel can deal with a fire in this phase - employees should be able to put out a fire at this stage. There are many examples of how personnel have been able to put out a fire with the help of a hand-held fire extinguisher or a fire hose. Some experts also note the importance of sprinklers.

The most effective measures to limit consequences of fires
It is important to have automatic fire alarms for early detection and equipment and training so that evacuation can start and the fire be put out or its spread limited. One major difficulty in public buildings is to make people understand how dangerous the situation is and the need to leave the building. The fire brigade's capacity to assist people in their escape is also important, as is systematic self-auditing of the fire protection.

Alternative strategies for fire protection
It is important to have a high level of fire safety in public buildings since otherwise visitors are exposed to danger. People in the building have a right to expect that those who build or lead the activities there have considered the risk of arson and taken measures to protect visitors from it. Weaknesses in terms of ease of ignition must be identified and dealt with.

New testing methods should be developed to cope with criminal and terrorist deeds. Testing methods should take account of larger scale fires than those in today's "single-burning-item" and "smokers-item" tests. Loose fittings and surface materials are only required to withstand small ignition sources. Room surface materials will not be able to withstand a fire which has been able to develop in a concealed space or an arson attack which provides a much more powerful ignition source.

For many years people have overestimated how the fire brigade can perform in the event of a fire. These expectations will hopefully be more realistic in the future. It is hoped that those responsible as builders or occupants of a building will become more aware of their role in fire protection and realise that they cannot just rely on the fire brigade.

The local fire authorities should develop their work with inspection and supervision so that better judgements can be made. All the legal obligations lie on the proprietor and this can make it difficult for the fire brigade to gain insight into how fire protection in a building is organised. This can be particularly problematic if the proprietor does not take this responsibility seriously enough. Inspections should be carried out without forewarning, for example to expose locked emergency exits. The local fire authority's support for systematic self-auditing of fire protection by those responsible for activities in a building must also be improved.

6.5 Flame retardants

The experts were asked some questions about flame retardants in the context of fire protection for homes and public buildings.

6.5.1 The effect of flame retardants on fire growth

Flame retardants are used to make ignition more difficult and to slow down the initial fire growth. They can make the initial fire develop more slowly or even make it go out. However the experts pointed out that if a source of ignition gives a large exposure to radiation then flame retardants will be less important. They are also of less effect if the fire spreads or grows to a certain size. Flame retardants have different effects for different kinds of plastics. It was noted that for the most common plastics (polystyrene, polypropylene and polyurethane) flame retardants are only effective in the initial stage of a fire. When a fire is established, the total quantity of plastic is more decisive for the fire's development than whether or not the plastic is treated with flame retardant. The role of flame retardants is considered more important in the home environment than in public buildings, among other things because the quantity of plastics in a home is much larger in relation to room size.

The interviewed experts pointed out the importance of understanding that flame retardants are not the only way to achieve fire protection. Suitable fire properties can be achieved in other ways. For example a sofa can be considered: a cover made from a naturally fire resistant material can be an alternative to protection with flame retardant chemicals.

6.5.2 Research on flame retardants

All those interviewed would like to see more research done on fire resistance and flame retardants. A wide range of flame retardants are available. Today most research is done on the effects of flame retardants in the environment. Other areas of interest are:

- The importance of flame retardant for fire protection
- How flame retardants function and what effects they have
- Alternatives to dangerous flame retardants

The effects that flame retardants have for fire safety should be quantified. They must be set in a larger context, together with other protection measures.

The ways that different flame retardants work should be better understood. What effects do they have in preventing ignition and what effects do they have on fire growth? It would be alarming if they slow down fire spread but instead lead to a greater production of smoke.

Flame-retarded products are today tested with relatively small ignition sources. How do they behave when exposed to larger fires, as in arson?

Alternative flame retardants that could replace those with negative consequences for the environment should be developed. The development of alternative ways to protect products from fire other than flame retardants should also be encouraged. There is a also a more general need to improve our ability to make decisions that take different kinds of consequences into account, enabling us to weigh up fire protection advantages against environmental disadvantages.

7 Conclusions

We conclude this report with a discussion about fires and fire safety in homes and public buildings. In this chapter the authors take up what in their opinion constitute the most important aspects that have come to light in the study of statistics and interviews with Swedish experts.

7.1 Injuries and deaths due to fire

In injury prevention it is common to illustrate different kinds of injuries as a pyramid or iceberg. The statistics that are most often quoted are for the tip of the iceberg – deaths. The large numbers of injuries from fire pass unnoticed under the surface. Non-fatal injuries are often divided into major injuries requiring treatment as a hospital inpatient and minor injuries which are treated at accident and emergency departments in hospitals or health centres but not as inpatients.

For accidents in general in Sweden there are about 30 major injuries per death and 200 minor injuries (see Olyckor i siffror, NCO/SRSA). The distribution is quite different for fires. There are only seven major injuries per death, and similar numbers of major injuries as minor injuries. Accidents in general have the ratio 1:30:200 whereas fire has 1:7:7.

The approximate figures for fire injuries per year in Sweden are 100 deaths, 700 major injuries and 700 minor injuries. This corresponds to rates of 11, 80 and 80 per million population respectively.

7.2 Fire safety strategies

Fire safety is a complex subject. Fire risks vary greatly in different situations – there is no general fire problem and consequently no universal solution to ensure fire safety. Fire protection strategies for a certain environment should be adapted to the specific aspects of the fire risks in that particular environment.

A fire can be considered in a very simplistic manner as a process starting with underlying causes and finishing with the negative effects of the fire:

Underlying causes → Object of origin → Ignition → Development of fire → Effects of fire

Fire safety strategies can focus on different links in the above chain. They can also deal in different ways with buildings as a whole, single items which we have in buildings or the behaviour of the people who occupy the buildings.

There are often several different ways to achieve a specific level of safety. The choice of the most appropriate protection measures will depend on the specific situation.

Examples of different strategies to cope with fire:

- Education, training and information to raise awareness and cautiousness of occupants, employees and those responsible for activities in a building
- Reduce the number of items which can be ignited

- Reduce the energy in ignition items
- Prevent the ignition of combustible materials in the ignition item or other item nearby
- Reduce the spread of the initial fire in the affected items/materials
- Prevent initial fire from developing in the affected item
- Reduce amount of toxic fumes that are produced
- Alert people at risk in the building (automatic detection)
- Extinguish the fire (automatic or manually)
- Provide ways for people to escape from the fire
- Alert the fire and rescue services

7.3 Home fires

7.3.1 Changes in rate of growth of home fires

When compared with the situation in the 1960s it would appear that fires in homes now develop more rapidly, peak at a higher temperature and produce more smoke and toxic fumes. This change is believed to depend mainly on the transition from the use of natural materials in furniture and loose fittings to the use of plastics. The typical fire load in a home has increased due to the use of plastics and possibly also due to homes containing more (combustible) possessions as the population has become more affluent.

7.3.2 Strategies for fire protection in homes

Swedish experts point to a number of strategies to deal with fires in homes:

- Educate and inform people about fire risks and fire protection
- Smoke detectors to ensure an early detection of any fires that do occur
- Increase the ability to put out small fires for example with a hand-held fire extinguisher

Smoke detectors make it possible for the residents to evacuate safely or even put the fire out while it is still small. Fire education for the public increases their cautiousness in dealing with items that can cause ignition and improves their preparedness to act when a fire does break out.

7.3.3 Fatal fires

The death rate in fires in Sweden has improved quite markedly since 1945. This is due to a reduction in the number of males aged 15-64 dying from burns. We have not been able to identify the factors which have caused this improvement.

The vast majority of fatal fires occur in homes and usually only cause the death of one person. The elderly and the unemployed or those of low income are over represented among those dying in fires.

The dominant fire cause is carelessness when smoking. Fire safety for smokers could be improved if better ways were found to prevent a dropped cigarette from igniting whatever it falls onto. One way to do this is to introduce fire safety requirements for clothes, bedclothes and furniture. Another way to achieve the same objective would be to introduce cigarettes that

do not ignite things when they are dropped. Cigarettes with reduced ignition properties have been developed. The paper on the outside of the cigarette is of variable thickness. The smoker must inhale through the cigarette for the thicker paper to burn. Without inhalation the cigarette will only burn until the next thicker layer of paper is reached. Should such a cigarette be dropped then the outermost section will usually not contain enough energy to ignite the material that it has landed onto. These cigarettes are available in other parts of the world and will perhaps prove a more effective and appropriate way to improve fire safety than an increased general use of flame retardants in clothing and furniture. The introduction to Europe of cigarettes with reduced ignition properties could lead to a reduction in the fire death rate.

It is clear that the elderly and those marginalised in society run a much greater risk of dying in fires than the population in general. The number of old people is expected to increase dramatically in the future. It is also likely that the marked recent increase in alcohol consumption will eventually lead to an increase in the number of marginalised individuals with serious alcohol problems. These two trends pose a clear challenge to fire safety in the near future. It is therefore important to find ways to make smoking, using candles and using cookers more safe for these two risk groups, since these causes cover at least 60 % of all fire deaths.

7.4 Public buildings

7.4.1 Fire risks in public buildings

According to experts, the size of fire compartments in public buildings has increased significantly over recent decades. The buildings have become increasingly complex. They are now built to be more flexible in their use and the activities taking place in a building can change relatively often. In addition to all these factors which make fire protection problematic, public buildings are relatively often subjected to arson.

7.4.2 Strategies for fire safety in public buildings

Fire safety in the home is relatively straightforward when compared with fire safety in public buildings, due to the fact that there are so many more variables to take into consideration in public buildings. Experts identify the following strategies as most important for efforts to improve fire safety in public buildings:

- Education and training of personnel
- Systematic fire safety policy for those responsible for activities in the building
- More relevant testing of products (loose fittings and surface materials)
- Ensure an early detection of any fires that do occur
- The fire brigades must be well prepared for fires in public buildings since in certain situations they may be required to help people escape from a fire

Education of personnel and self-auditing of a systematic fire safety policy have an important role to play in improving insight on fire risks and how to deal with fires when they do occur. Hopefully this can improve the effectiveness of fire prevention and the response in the initial stage of the fire development.

The experts point out how important it is to have relevant fire testing of furniture, loose fittings and surface materials for use in public buildings. Single-item testing does not always

reveal how a product will behave in a real environment. The tests themselves are based on relatively limited ignition sources which are relevant for technical fire causes but not realistic when considering how an arsonist might try to start a fire – and this is the most common fire cause in public buildings.

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Appendices

Appendix 1, Statistical tables

Appendix 1 table 1

Number of fatal home fires per month,

Sweden, 2004 and average for 2000-2004

Source: Fatal fire statistics, Swedish Rescue Services Agency

	2004	Average 2000-2004
January	4	8,2
February	4	9,2
March	5	9,6
April	4	6,8
Maj	4	6,0
June	2	4,0
July	4	3,6
August	0	4,0
September	5	5,4
October	3	6,4
November	3	8,0
December	10	11,6
Total	**48**	**82,8**

Appendix 1 table 2

Number of fatal home fires per day of the week,

Sweden, 2004 and average for 2000-2004

Source: Fatal fire statistics, Swedish Rescue Services Agency

	2004	Average 2000-2004
Monday	6	7,8
Tuesday	7	11,6
Wednesday	6	10,0
Thursday	6	12,6
Friday	6	11,2
Saturday	10	15,4
Sunday	7	14,2
Total	**48**	**82,8**

Appendix 1 table 3

Number of fires in blocks of flats attended by fire brigade per cause, Sweden, 1996-2004

Source: Turn-out statistics, Swedish Rescue Services Agency

	1996	1997	1998	1999	2000	2001	2002	2003	2004	Total
Cooking appliance left on	511	484	555	590	739	644	658	636	656	5473
Arson	497	381	528	450	391	434	377	366	330	3754
Technical fault	196	231	235	209	269	228	187	186	161	1902
Candle	164	155	195	175	207	161	171	163	169	1560
Smoking	147	161	165	180	178	185	167	175	151	1509
Heat transfer	93	76	129	140	131	121	106	88	68	952
Chimney fire	78	104	134	180	197	72	34	34	26	859
Child playing with fire	80	80	62	68	76	62	53	39	36	556
Fireworks	40	27	24	45	39	31	21	22	38	287
Spontaneous combustion	25	29	40	41	38	24	28	25	23	273
Sparks	19	29	45	34	41	22	5	15	11	221
Hot work (often with gas burner)	18	22	14	17	15	18	18	20	11	153
Re-ignition	13	14	11	11	15	11	5	13	10	103
Lightning	7	13	5	6	13	1	1	4	1	51
Explosion	5	9	5	4	5	4	7	2	5	46
Other	266	262	160	169	153	184	137	171	152	1654
Unknown	1350	1234	858	911	847	698	803	693	603	7997
Total	**3509**	**3311**	**3165**	**3230**	**3354**	**2900**	**2778**	**2652**	**2451**	**27350**

Appendix 1 table 4

Number of fires in detached houses attended by fire brigade per cause, Sweden, 1996-2004

Source: Turn-out statistics, Swedish Rescue Services Agency

	1996	1997	1998	1999	2000	2001	2002	2003	2004	Total
Chimney fire	1163	1151	1204	1058	788	1190	1079	1164	909	9706
Technical fault	284	252	276	303	235	231	287	255	212	2335
Heat transfer	196	219	243	216	184	251	271	259	217	2056
Cooking appliance left on	126	149	153	143	137	157	144	134	108	1251
Sparks	122	130	128	92	102	121	133	167	114	1109
Lightning	29	98	33	32	48	54	52	60	52	458
Candle	53	47	47	56	62	47	53	45	41	451
Arson	42	45	45	41	47	61	45	47	44	417
Re-ignition	38	57	31	35	32	32	37	55	43	360
Spontaneous combustion	27	40	47	42	31	42	44	46	31	350
Child playing with fire	43	30	18	26	21	22	22	16	15	213
Hot work (often with gas burner)	25	37	17	23	18	30	16	20	20	206
Smoking	15	29	18	20	16	22	29	23	19	191
Explosion	9	9	2	10	4	12	8	7	5	66
Fireworks	6	3	8	5	12	2	2	4	2	44
Other	272	211	140	114	105	148	141	156	166	1453
Unknown	790	555	420	452	399	492	469	538	443	4558
Total	**3240**	**3062**	**2830**	**2668**	**2241**	**2914**	**2832**	**2996**	**2441**	**25224**

Appendix 1 table 5

Number of fires in terraced/semi detached houses attended by fire brigade per cause, Sweden 1996-2004

Source: Turn-out statistics, Swedish Rescue Services Agency

	1996	1997	1998	1999	2000	2001	2002	2003	2004	Total
Cooking appliance left on	39	46	50	40	40	30	36	31	39	351
Technical fault	38	44	29	33	30	34	33	39	30	310
Candle	16	28	19	18	19	21	21	15	13	170
Heat transfer	7	17	16	11	18	16	11	11	14	121
Arson	14	11	10	6	9	13	8	9	7	87
Smoking	6	7	4	8	6	9	7	6	4	57
Child playing with fire	6	11	13	5	10	1	2	2	6	56
Chimney fire	4	9	6	6	4	9	3	4	4	49
Spontaneous combustion	3	3	4	5	5	6	1	2	3	32
Re-ignition		1	1	3	4	1	5		3	18
Sparks	1	2	2	1	3		2	1	1	13
Hot work (often with gas burner)		3	2	2	1	3		1	1	13
Fireworks	3	1	2			2	3		1	12
Lightning		2	1		1	4		1		9
Explosion					1			1		2
Other	20	21	15	14	9	12	8	9	14	122
Unknown	60	73	58	67	48	47	44	37	44	478
Total	**217**	**279**	**232**	**219**	**208**	**208**	**184**	**169**	**184**	**1900**

Appendix 1 table 6

Number of fires in summer cottages attended by fire brigade per cause, Sweden 1996-2004

Source: Turn-out statistics, Swedish Rescue Services Agency

	1996	1997	1998	1999	2000	2001	2002	2003	2004	Total
Heat transfer	62	57	44	38	59	72	42	49	47	470
Chimney fire	21	22	40	38	29	37	27	23	22	259
Arson	26	25	16	23	37	27	25	25	21	225
Technical fault	16	19	27	28	17	20	21	23	20	191
Lightning	13	31	9	8	21	18	26	23	12	161
Sparks	18	22	10	18	23	16	9	15	5	136
Re-ignition	7	8	5	10	4	3	8	9	6	60
Cooking appliance left on	4	3	8	2	7	4	8	8	8	52
Child playing with fire	10	8	5	3	5	1	6	5	2	45
Candle	2	3	2	4	7	3	2	4	2	29
Smoking	1	3	4	6	2	2	1	5	2	26
Spontaneous combustion	3	2	6		1	3	6	2	1	24
Explosion			3	2	3	1				9
Hot work (often with gas burner)	2	4				1		2		9
Fireworks			1	2						3
Other	42	24	15	17	25	11	12	23	25	194
Unknown	166	163	103	114	108	138	136	148	110	1186
Total	**393**	**394**	**298**	**313**	**348**	**357**	**329**	**364**	**283**	**3079**

Appendix 1 table 7

Proportion of home fires which led to fire service turn-out or payment from insurance company

Estimates and confidence intervals

Source: questionnaire survey by Statistics Sweden for Swedish Rescue Services Agency

Fires in the home which were not under control and which led to injury or damage	
Fire not attended by fire brigade and no insurance payment	51,9% +/- 8,7%
Fire attended by fire brigade but no insurance payment	18,3% +/- 6,3%
Fire attended by fire brigade and insurance payment	21,6% +/- 7,9%
Fire not attended by fire brigade but insurance payment	8,2% +/- 4,3%

Appendix 2, Fire death definitions from the International Classification of Diseases

The International Classification of Diseases (ICD)-10 was endorsed by the 43rd World Health Assembly in May 1990 and came into use in World Health Organization (WHO) member states as from 1994. The classification is the latest in a series which has its origins in the 1850s. The first edition, known as the International List of Causes of Death, was adopted by the International Statistical Institute in 1893. WHO took over the responsibility for the ICD at its creation in 1948 when the Sixth Revision, which included causes of morbidity for the first time, was published.

The ICD has become the international standard diagnostic classification for all general epidemiological and many health management purposes. These include the analysis of the general health situation of population groups and monitoring of the incidence and prevalence of diseases and other health problems in relation to other variables such as the characteristics and circumstances of the individuals affected.

It is used to classify diseases and other health problems recorded on many types of health and vital records including death certificates and hospital records. In addition to enabling the storage and retrieval of diagnostic information for clinical and epidemiological purposes, these records also provide the basis for the compilation of national mortality and morbidity statistics by WHO Member States.

The study of fire deaths and injuries cover extended periods, during which different versions of the ICD were in use. The table below shows the specific codes used to select individuals for the study (five external causes, all of which are related to fire in one way or another). Three main diagnoses or medical consequences of these five external causes were studied – burns, carbon monoxide poisoning and other consequences.

	ICD 9	ICD 10
External causes		
Exposure to controlled or uncontrolled fire in building or structure	890-891, 895	X00, X02
Exposure to controlled or uncontrolled fire, not in building or structure	892, 896-897	X01, X03
Exposure to ignition of highly flammable material	894	X04
Exposure to ignition or melting of nightwear or other clothing and apparel	893	X05, X06
Exposure to other specified or unspecified smoke, fire and flames	898-899	X08, X09
Consequences of external causes		
Burns and corrosions	940-949	T20-T32
Toxic effect of carbon monoxide	986	T58
Other	Other	Other

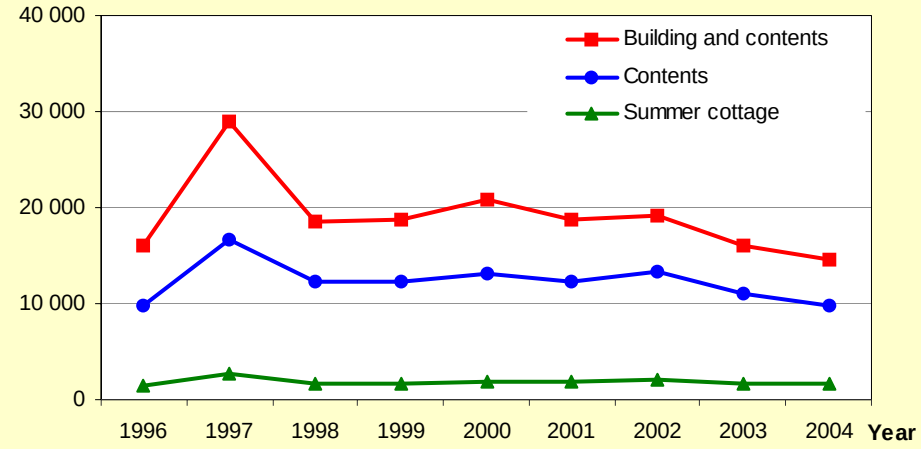
Appendix 3, Insurance statistics on home fires

The number of fires is far higher in Swedish insurance statistics than in the fire service statistics. There are several factors which explain why this is so:

- The Swedish Insurance Federation collate statistics on the number of accepted claims for compensation, not the number of individual fires. In many cases one fire can result in compensation to several claimants.
- Faults in appliances due to lightning or electrical short circuits are covered by the fire clause in home insurance, even though the damage very rarely gives rise to a fire. In recent years the Federation statistics show how often these faults actually caused fires. In 2004 only 6 % of such faults led to fires. Lightning/short circuits account for nearly half of all claims under the fire clause, so over 44 % of all fire clause claims were not actually in connection with fires.
- In some cases the claimant manages to extinguish the fire without needing to call the fire brigade.

It should be borne in mind that not all homes are covered by fire insurance, and even if a home is insured, the damage may not be greater than the excess in the insurance policy so the victim may choose not to make a claim. There will therefore be cases when fires reported by the fire brigade do not result in an insurance claim.

The number of home insurance claims leading to payments by Swedish insurance companies is shown in the diagram below. Those living in blocks of flats insure their possessions - the contents of their flat. Any damage to the building itself is covered by the landlord's insurance which is a separate policy not in the home category. Single-occupancy homeowners usually have an insurance policy covering both the building and its contents.



Home insurance claims that led to payments by insurance companies, Sweden, 1996-2004

Source: B1-statistik, Swedish Insurance Federation

The peak in 1997 would appear to be attributable to an unusually high number of thunderstorms in the late summer and early autumn, leading to many electrical faults which did not start fires. Such insurance claims give rise to small payments. There is no corresponding peak in payments for 1997, as seen in the diagram in appendix 4.

Appendix 4, Financial losses from fires

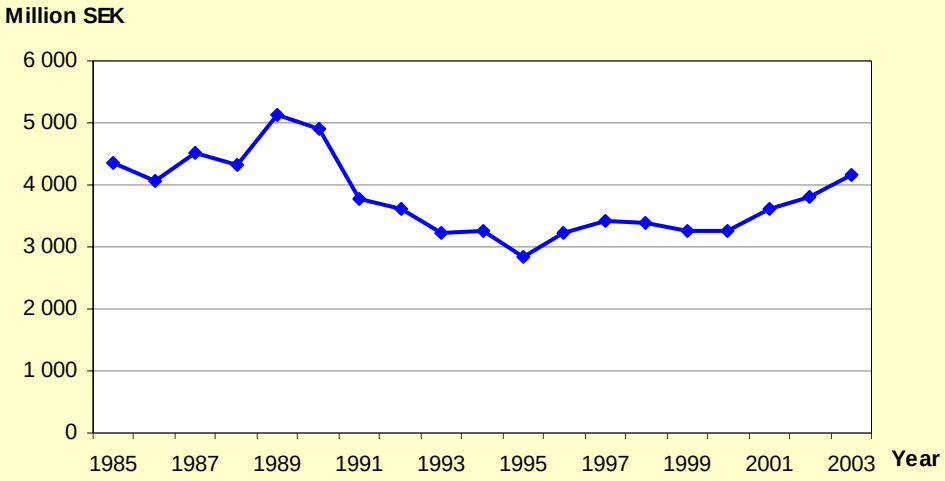
Insurance statistics

Financial losses are only a small portion of the total cost to society of fires. However estimating the societal cost of fire is beyond the scope of this study. We refer interested readers to some well-known sources in the list of references in the appendix and instead limit ourselves to a presentation of financial losses as reported by the insurance companies.

The Swedish Insurance Federation publish statistics on the compensation paid out by insurance companies operating in Sweden. The figures from the federation are reasonably comprehensive, accounting for more than 95 % of the insurance business in Sweden. However it should be remembered that not all financial losses are covered:

Most policies have an excess – only sums exceeding this amount are compensated
Some people forget to insure their property or choose not to do so
Large companies and municipalities have their own ”captive insurance companies” which do not report to the Insurance Federation
The Swedish state manages its financial risk without using insurance companies

In Sweden it is sometimes claimed that fire costs are escalating. However this is not the impression given by the statistics from Swedish insurance companies. Total payments in fixed prices for 2004 are shown in the diagram below. Costs peaked in 1989 and have varied at a lower level since then.



Fire payments by insurance companies in fixed prices, 1985-2003
Source: Översiktsstatistik, Swedish Insurance Federation

Nordic comparison

Research scientist Bodil Aamnes Mostue from SINTEF NBL as and Ph.D. Vidar Stenstad from Byggforsk in Norway have recently presented a comparison of deaths and insurance

payments caused by fire in Denmark, Finland, Norway and Sweden. Statistics from various sources were collated and relevant indicators chosen to enable comparisons.

The authors conclude that fires leading to compensation from insurance companies are not more common in Norway than the other countries in the study. There are roughly similar numbers of claims per inhabitant and fires per inhabitant as in Sweden, Denmark had somewhat more and Finland had least.

Norway has experienced a marked increase in fire losses over the last ten years, due to increased costs for home fires. In the mid-1990s home fires accounted for 50 – 60 % of the total fire losses in Norway. By 2003 this figure had risen to 75 %. In the other countries home fires make up less than 40 % of the total.

In the period 2001-2003 home fire payments from insurance companies were 2.5 times higher in Norway than in Sweden. This corresponds to five times higher losses per inhabitant. Home fire payments accounted for 0.18 % of Norway's gross domestic product, compared with only 0.05 % in Sweden. Payments per fire claim were four times higher in Norway than in Sweden. The authors adjust the figures to take into account the greater floor area in Norwegian homes and differences in the kinds of houses in the two countries. When adjusted, the compensation paid by insurance companies is only 2.2 times higher per fire in Norway than in Sweden.

In the last four years building costs have risen by 40 % in Norway but remained more or less constant in Sweden. It is only a small proportion of all home fire payments in Norway that are over one million NOK. The three percent of home fires with compensation of more than one million NOK account for 75 % of the total payments. The total compensation for all the fires that cost less than one million NOK has remained constant for the last 15 years.

It would appear that it is more common to demolish homes and rebuild them from scratch in Norway than it is in Sweden or Denmark. In Sweden and Denmark fire-damaged structures are more likely to be repaired. This could be due to the use of different building materials, it being easier and cheaper to repair stone and concrete than wooden structures. The authors identify this as one possible contributory factor to the higher cost level in Norway. A deeper analysis of material from individual insurance companies would be needed to quantify the effect of differing policies towards rebuilding or repairing in the various countries on the level of home fire payments.

Fire losses per inhabitant for other policies than home insurance were roughly the same in Sweden and Norway, with Denmark at a higher level and Finland lower.

Appendix 5, Presentation of Swedish experts in interview study

Björn Albinson
Fire Protection Engineer, Emergency Prevention Department, Swedish Rescue Services Board

Björn Albinson worked as a Fire Protection Engineer in the city of Linköping from 1967 to 1984. When the Swedish Rescue Services Agency was formed in 1986 Björn was head of the section for fire suppression. He subsequently worked as project leader for the fire and rescue service information bank (RIB) and between 1994 and 2000 worked with environmental issues in the fire and rescue service. He went on to work with fire prevention and since 1998 has had special responsibility for flame retardants and loose fittings.

Björn Albinson is the chairman of the European Union Fire Safety Network and prior to that was project leader for two EU projects - prevention of fire and other incidents, and fire investigation. He is a member of the Swedish Fire Research Board and a member of the Green Flame advisory board. Björn has also worked as a Swedish delegate in European standardisation of fire extinguishing media and fire suppression systems since 1990.

Göran Holmstedt
Professor, Department of Fire Safety Engineering, Lund University

- Civ.ing (Master of Science) in technical physics, Lund University 1966
- Techn. Lic. Physics, Limits of flammability Lund University 1971
- Ph.D. Physics, Natural convection, limits of flammability Lund University 1979

Commission of trust:
Board member of the international committee (participants from UK, F, FIN and SE) that developed the fire-specific CFD-Code SOFIE
Dean of studies, National Center of Combustion Science and Technology, CECOST; 1997-,
Manager of Lund University Combustion Centre LUCC 2004-
Project leader for the CECOST flame spread project including five Ph.D. students at five different departments
Project leader for the CECOST project Spontaneous ignition including two Universities and the Swedish Testing and Research Institute

Professional experience:
Computational Fluid dynamics (CFD) models and applications
Risk associated with industrial fires
Fire suppression and detection
Evaluation of fire test methods and measurement techniques
Pollutants and risks associated with the use and storage of natural gas
Spark breakdown and ignition kernel development
Laser diagnostic techniques
Part time work for the National Accreditation Bureau SWEDAC. (Fire and textile labs in north Europe)

Göran Schnell
Managing Director, Swedish Fire Protection Association
Göran Schnell is managing director of the Swedish Fire Protection Association. He started as a fireman in 1967. In 1971 he qualified as a Fire Protection Engineer. For 13 years he was Chief Fire Officer in Uppsala, Sweden's fourth largest city. From 1999 to 2003 Göran worked with international fire and rescue cooperation in the United Nations and NATO.

Göran Schnell has represented fire officers in a number of organisations. He has been president of the Swedish Fire Officers Association, president of the Federation of European Union Fire Officers Associations and a board member of the International Council of the Institution of Fire Engineers.

Göran Schnell has also been active in fire research as a member of the Swedish Fire Research Board.

Ulf Wickström
Professor, Department of Fire Technology, Swedish National Testing & Research Institute

Professor Ulf Wickström heads the Department of Fire Technology at the Swedish National Testing and Research Institute (SP). The department has a staff of about 55 involved in fire testing and research. He was given the title "professor" in 1988 by the Department of Industry of the Swedish Government. His special scientific interest lies in heat transfer analysis of structures exposed to fire, a subject on which he has published several scientific papers.

Prof. Wickström joined the Department of Fire Technology of SP in 1979 and has been leading it since 1986. The laboratory is one of the foremost of its kind in the world, active in international research as well as providing direct services to industry in the field of fire safety testing and evaluation.

Prof. Wickström has been active during his entire career in international research and standardisation committees and working groups and is internationally well known in the field. For more than 10 years, he has led the Swedish delegation in the European standardisation committee on fire safety.

Prof. Wickström holds a Ph.D. from the Lund University of Technology (1979) in fire technology, a Master of Science from University of California (1977), Berkeley, and Master of Science in civil engineering from the Lund University of Technology (1974).

Appendix 6, Presentation of authors

Omar Harrami *(chapters 6-7)*
Risk Analyst, Research and Analysis Department, Swedish Rescue Services Agency

Omar Harrami has worked at the Swedish Rescue Services Agency since 1995. Besides working as a risk analyst Omar is also a part-time PhD-student at the department of Fire Safety Engineering at Lund University.

In 1993 Omar qualified with a degree in Fire Protection Engineering (Bachelor of Science) from Department of Fire Safety Engineering at Lund University. The following year he passed the Senior Officer Training for Fire Protection Engineers at the Swedish Rescue Services College in Revinge.
Member of the Swedish Fire Research Board (2003 - 2005)

Colin McIntyre *(chapters 1-5, 7, appendices)*
Statistician, National Centre for Learning from Accidents, Swedish Rescue Services Agency

Colin has worked with statistics at the Swedish Rescue Services Agency since 1990. The work started with an analysis of the statistical needs within the fire and rescue service. Once the long-term statistics programme was agreed Colin went on to lead a project group with the task of developing a turn-out report form for use in the municipal fire and rescue service together with a national system for the production of turn-out statistics. The report form and statistics production system have been running nationwide since 1996.

In recent years Colin has been involved in the development of accident investigation methods for use in the municipal fire and rescue service. The focus of Colin's work is the collection, analysis and dissemination of investigation data, an area of rapid development in the near future since accident investigations have become a legal obligation for the municipalities as of 2004.

Colin holds a BSc (Honours) in Mathematics from the University of Edinburgh, Scotland (1984)

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