Table 1. The direct damage costs caused by electrical fires by type of building

Building type	n	The 5% adjusted average of damage costs	Total damage cost
Industrial building	176	497 970 FIM	87 642 720 FIM
Dwelling houses	1121	53 186 FIM	59 621 506 FIM
Detached one-family houses	525	75 728 FIM	39 757 200 FIM
Terraced or link houses	37	107 704 FIM	3 985 048 FIM
Apartment houses	419	41 833 FIM	17 528 027 FIM
Type unknown	140	22 459 FIM	3 144 260 FIM
Educational building	25	1 556 244 FIM	38 906 100 FIM
Agricultural building	27	764 667 FIM	20 646 009 FIM
Business premise	166	45 609 FIM	7 571 094 FIM
Health care building	77	95 758 FIM	7 373 366 FIM
Public halls	75	42 749 FIM	3 206 175 FIM
Warehouse	25	80 111 FIM	2 002 775 FIM
Office building	53	17 117 FIM	907 216 FIM
Other buildings	13	25 833 FIM	335 829 FIM
Total	1 758		228 212 790 FIM

Figure 5. The distribution of electrical fires among different times of the day[4]

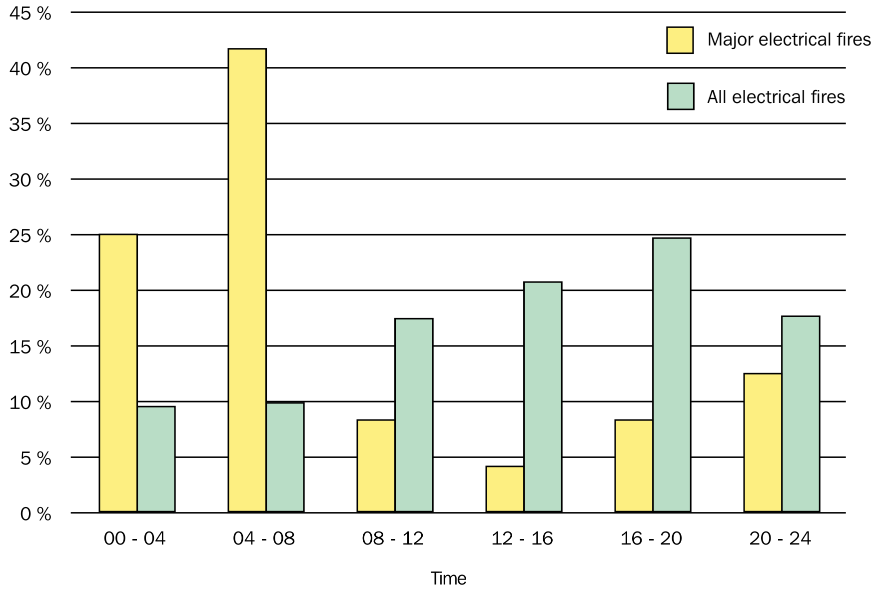
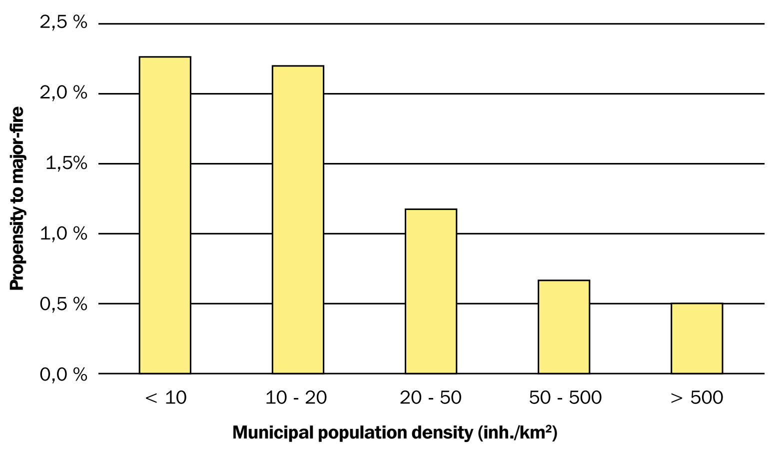


Figure 6. The propensity to major fire and municipal population density.



have a significant effect on electrical fires. Relatively fewer electrical fires occurred early in the morning (between midnight and 8 a.m.) and in sparsely populated municipalities (< 20 inh./km^2) than in other municipalities, but there were many more major electrical fires.

Approximately two thirds of all electrical fires occurred in the daytime between 8 a.m. and 8 p.m. (figure 5). However, approximately two out of three major electrical fires occurred in the early hours from midnight to 8 a.m. For example, no major fires, initiated in production machinery, occurred between 8 a.m. and 4 p.m., whereas 67 % of them occurred between 4 a.m. and 8 a.m.

By comparing the number of major electrical fires to all electrical fires in different population density categories, we get the propensity to major fire according to the municipal population density category (figure 6). The propensity to major fire in sparsely populated (< 20 inn./km^2) municipalities is more than four times as big as that in the most densely populated (> 500 inh./km^2) municipalities. The average population density in Finland is 16.9 inhabitants per square kilometre.[5]

CONCLUSIONS

Based on the results, the owners and keepers of different buildings and electrical equipment, either businesses or private people, get new facilities to recognise, evaluate and manage their fire risks, related to electricity. When developing safety, one should remember that it should be the operators themselves that want to improve safety.

The number of electrical fires can probably be reduced specifically by investing in the informing of the consumers and enterprises of the fire risks caused by electricity, and by encouraging them to use the equipment safely and to maintain it in an organised manner. Rescue authorities and other people active in the rescue services, as well as professionals in the electrical and real estate sectors, have a central role in the prevention of electrical fires. The results of this study show that more accurate information can be offered to them on the causes and starting mechanisms of electrical fires to help them in fire prevention.

The study proved that the quick identification of a starting fire and the prompt response in extinguishing and rescue work have a significant effect on the amount of damage caused by the fire. Automatic fire detectors and extinguishing systems are efficient tools for decreasing damage, caused by fire. An increasing utilisation of automatic fire safety technology is very advisable, particularly in sparsely populated areas.

In Finland, the national accident database, maintained by the rescue authorities, has not been much utilised for the definition and prioritising of fire prevention activities. The results of the study support the point of view that the rescue authorities' estimates of the reasons for fires and of the equipment, causing a fire, are reliable enough to be utilised in fire prevention work, at least as far as electrical fires are concerned. Naturally, the utilisation of the information requires that the complete information is appropriately entered in the statistics and that there are functioning IT systems that support the utilisation of these statistics.

However, the current level of fire research and the rescue authorities' evaluations of the causes of fires do not provide enough information for the recognition of latent system-related causes. To prevent accidents, it would be appropriate to investigate fires beyond their direct causes. A more careful analysis of the reasons could help us find completely new viewpoints as a basis for fire prevention work. Some improvement to the situation could be reached by offering the rescue service and the police some further training related to electrical fire risks. A significantly more thorough fire research than today is in practice hardly possible on a large scale. To discover system-related causes, people should study the issue in more detail with regard to the most essential building types and groups of equipment.

Approximately 60% of all electrical fire cases lacked an estimation of damage costs caused by the fire. To correct the situation and to improve the damage estimates, the rescue authorities need tools. It would be useful for the complete picture of damage to property if criteria for estimating the damage costs could be provided to those participating in fire investigation.

There is currently not enough information of deaths or other personal damage, caused by fires, so as to reliably estimate the personal damage risk due to fire based on it. In order to improve the situation, deaths due to fires should be followed up, including delayed deaths, and injuries due to fires should be investigated and entered in the statistics.

[1] Rahikainen, J. Palokuolemat Suomessa vuosina 1988-1997. Poliisiammattikorkeakoulun tutkimuksia 4/1998.
[2] direct damage more than FIM 1,000,000
[3] Consumption study 1998, Statistics Finland.
[4] The sum of both column groups is 100%.
[5] Statistics Finland 1999.

Source

Nurmi, V-P. Sähköpalojen riskienhallinta (Risk Management of Electrical Fires). TUKES Publications Series 3/2001. ISSN 1455-0822. ISBN 952-5095-46-0. (in Finnish)

Participants in the project:

The research project was accomplished as part of the research programme aiming at the development of electrical fire safety, which was started by the Safety Technology Authority (TUKES) in 1996.

At the information collection stage, the leading fire investigator of TUKES was Ulf Westerstråhle, who is permanently employed as the Fire Chief for the municipality of Valkeala. Other fire investigators in the project included Fire Master Veli-Matti Sääskilahti and Project Director Veli-Pekka Nurmi from TUKES. The research assistants were Safety Engineers Marko Hämäläinen and Mikko Törmänen from TUKES.

The follow-up group consisted of the representatives of the Finnish National Rescue Association, the Finnish Association of Fire Chiefs, the National Bureau of Investigation, the Finnish Fire Protection Promotion Foundation, the Finnish Fire Protection Fund, the Finnish Fire Research Board, the Emergency Services College, the Police College of Finland, and of TUKES.

The control group of practical activities was composed of the police and rescue service authorities of the research areas and of the representatives of TUKES.

The control group of the analysis stage included Risk Management Director Kari Häkkinen and Leading Expert Pekka Kallioniemi from the Industrial Insurance Company, Research Professor Matti Kokkala from the State Technical Research Centre of Finland (VTT), Professor Markku Mattila from Tampere University of Technology, Director of Non-Life Insurance Veli Matti Ojala from the Finnish Federation of Insurance Companies, Senior Safety Engineer Harri Westerlund from TUKES, and Chief Rescue Inspector Thor Åkesson from the Provincial Government of Southern Finland.

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ELECTRICAL FIRE RISKS

Summary of study

There has been only poor information available on what actually has caused electrical fires and on their ignition mechanisms. In the efforts to identify hazardous electrical equipment, installations, and misuse, it is essential to be able to compile truthful statistics on the evaluation of what has caused the electrical fires in different equipment groups and different types of buildings.

The object of the study was to define the equipment groups which caused electrical fires, their causes and damage in different types of buildings, and to suggest the most advisable preventive actions. The purpose of the study was also to find out the impact of time (month, day of the week and time of the day) and place (region and population density of the municipality) on the fire risk. In an electrical fire, electricity provides the source of heat.

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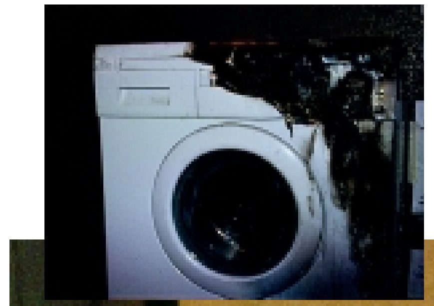
MATERIAL AND METHODS

The study concentrated on fires that were suspected to have been caused by electrical equipment, its installation or its incorrect use. The reasons for the assumed electrical fires were examined in the period from the 1st of September 1998 until the 31st of August 1999 in Vantaa and in the Rescue Services Co-operation Areas of Kouvola and Kotka. Outside the research area, all electrical fires were investigated that caused deaths, as well as major fires that were suspected to have been caused by electricity. In addition, reference information on all electrical fires in Finland during the period under consideration was collected and analysed. The information from the reference period was collected from every fire brigade and police department in Finland. The major-fire statistics of the Finnish Federation of Insurance Companies from the beginning of 1980 until the end of May 2000 were also utilised. In all 2,578 fires, which occurred during the research period, were analysed, of which 1,758 were proved to be electrical fires. In addition, the major-fire statistics of the Finnish Federation of Insurance Companies included 1,596 cases, of which 39 % were electrical fires.



RESULTS

On the basis of this study, electricity appears to be the cause for approximately 2000 fires per year, whereas earlier statistics account for about 1000 electrical fires per year during the last few years. According to this study, fires caused by electricity killed seven people within the one-year period under consideration. Moreover, more than ten very dangerous "near miss" incidents were recorded during the investigation. According to these figures, 0.4% = 4‰ of all electrical fires cause deaths. This means one death per approximately 250 electrical fires. All in all, an average of 150 fires causes the death of one person in Finland. Between 1983 and 1993, the proportion of fatal fires of all fires is Finland was between 4.9 and 8.0 ‰[1].

All fatal electrical fires occurred in homes. Except for one case, all of them started from the kitchen. The most common direct cause for a fire was the careless use of a stove. The average age of the victims of electrical fires was 62 years. In three cases out of seven, the victim was under the influence of alcohol.

Deaths, caused by fires, are typically only registered in the rescue authorities' database when a fire brigade finds a victim in the fire target during operative action. The police, or the rescue or other fire investigation authorities may not necessarily be aware of delayed deaths, due to fires, which take place in hospital. Therefore information on deaths, caused by fires, is probably not perfect. There is no information on other personal damage, related to the electrical fires under consideration. It is not even quite clear what other personal damage means. People in a building on fire may, for example, fall, trip or be exposed to other hazards when trying to save themselves.

The distributions of the research area (165 electrical fires) and of the follow-up area (1,593 electrical fires) by equipment group, cause for the fire, building type, day of the week and time of the day were very similar, and had no significant differences. As regards the total number of electrical fires, we noticed that there were clearly more fires in the research area than in the follow-up area, both in relation to the numbers of building, floor areas and numbers of inhabitants. The reason for this may be that some fires have not been reported in the follow-up area, in particular small electrical fires. The fires in the follow-up area may also include some electrical fires that were not considered to be electrical fires by the rescue authorities; as no crime was suspected, the police did not intervene in these cases either, so they remained unannounced.

In the research and follow-up area, 1.4% of electrical fires progressed to major fires. When comparing the distribution of major electrical fires[2] to the distributions of major electrical fires according to the statistics of the Finnish Federation of Insurance Companies, we can see that they are very similar with regard to day of the week, building type, cause for the fire, province, region, municipal population density and equipment group. The statistics of the Finnish Federation of Insurance Companies did not include information on the time of ignition or the time of alert.

Review of Equipment Groups

By defining the relationship between the electrical fire data of each equipment group to the number of equipment used, we can define the annual fire frequency of a single piece of equipment. These values can be used for comparison between different equipment groups. The equipment numbers used in the calculation are based on the information on the situation in 1998[3]. Of the most common causes of electrical fires, no equipment numbers were available for electrical installation, lighting device or production machinery.

Based on this definition, the electrical equipment with the greatest ignition risk, with a fire frequency of $1.3 \cdot 10^{-4}$ 1/a includes stoves, and electrical sauna stoves, with an ignition frequency of $1.1 \cdot 10^{-4}$ 1/a (figure 1). The third position in this comparison goes to central vacuum cleaners, due to the relatively small number of equipment used. The fire frequency of televisions and washing machines is approximately half of that of stoves, sauna stoves or central vacuum cleaners. The fire frequency of refrigerating equipment, microwave ovens or range hoods is approximately one tenth of that of a stove.

The defined fire frequency of a single piece of equipment can be used to see that annually approximately one out of 8,000 stoves, of 9,000 sauna stoves or central vacuum cleaners, of 17,000 television sets or washing machines, of 27,000 electrical heaters or of 81,000 pieces of refrigerating equipment causes a fire.

The major fires in the examined and follow-up area were caused by lighting device, electrical installation, electrical heaters, production machinery, refrigerating equipment and car heaters. The major-fire statistics of the Finnish Federation of Insurance Companies from the years 1980 – 2000 also bring up stoves, ovens and television sets (figure 2). Of the reasons for major fires, technical faults were the most common with an 86% proportion, while the proportion of incorrect action or use was 13%. The impact of incorrect action or use is clearly smaller in major fires than in other electrical fires.

Figure 1. The ignition frequency of a single piece of equipment in some groups of electrical equipment

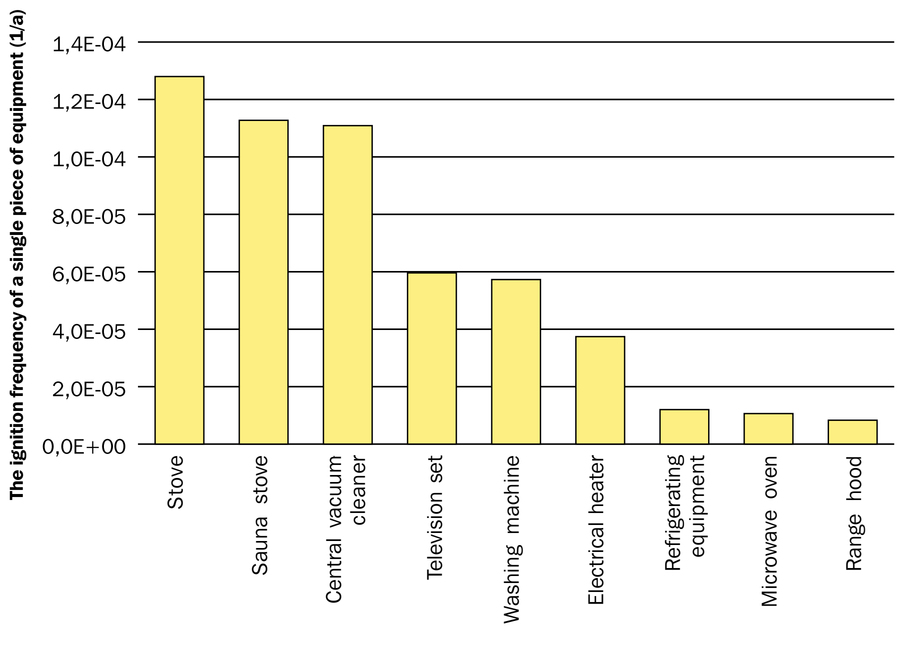
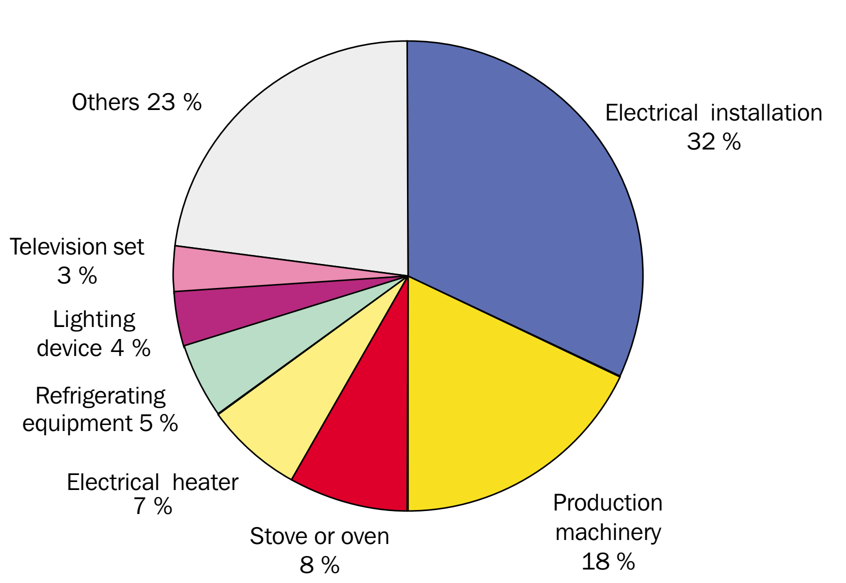


Figure 2. Electrical equipment causing fires in major fires between 1980 and 2000 (n=333)



Review of building types

Most electrical fires, and damage caused by them, occur in homes. Information on the numbers of electrical fires alone is not enough for risk definition, because there are very different numbers of different building types, and the size distribution of the buildings varies considerably, depending on building type. Comparisons can be made between different building types by defining the fire frequency of each building type, in relation to the number of buildings and to floor area.

If reviewed based on the number of buildings, the most problematic building types include health care buildings, apartment houses, public halls, industrial buildings, office buildings and business premises (figure 3). If defined by floor area, the electrical fire frequency is highest in public halls, in business premises, health care buildings, apartment houses, industrial buildings and in detached one-family houses.

Figure 3. Electrical fire frequencies by number of buildings and by floor area

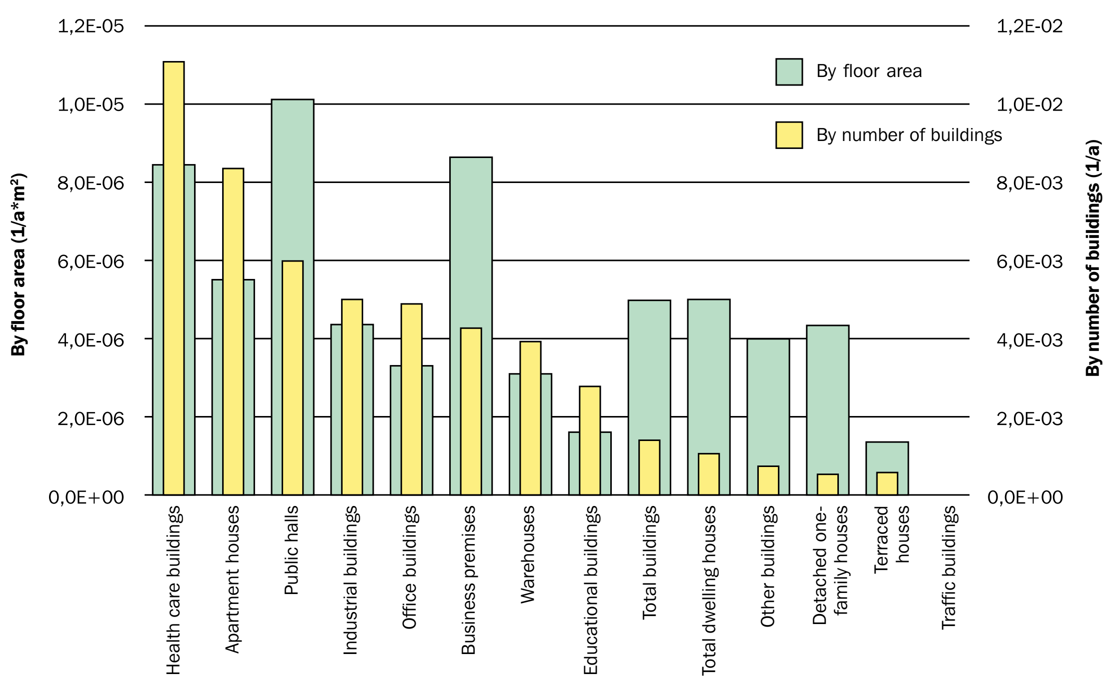
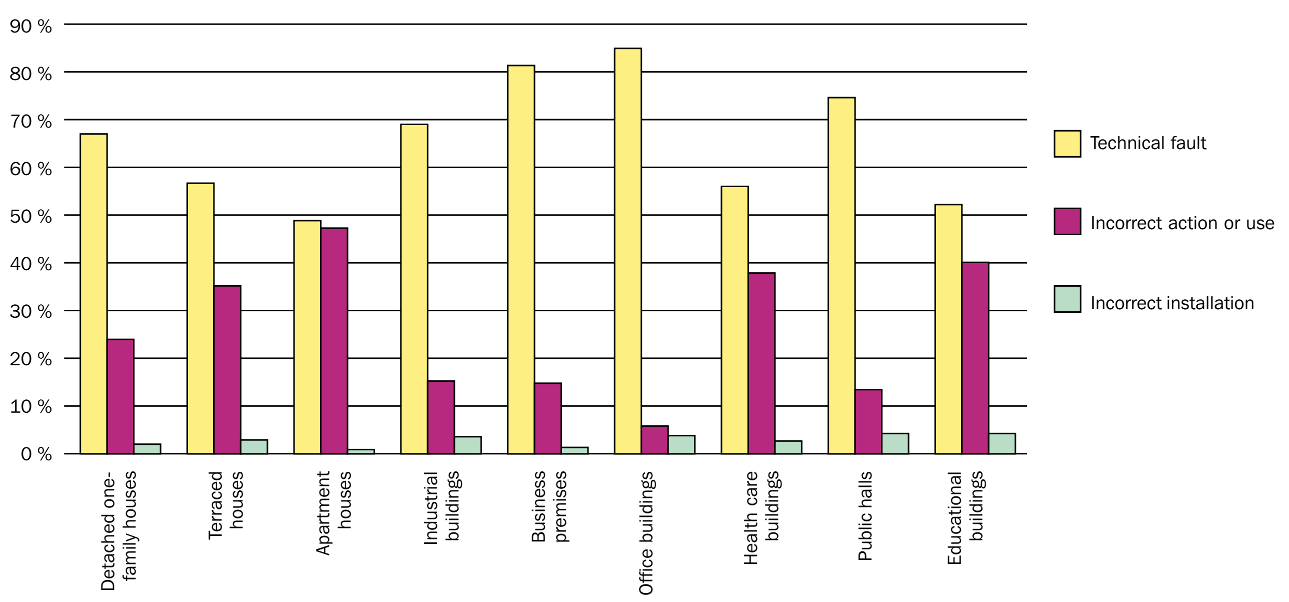


Figure 4. The direct causes for electrical fires in different types of buildings



The direct causes for the ignition of fire differ quite a lot, depending on the type of building (figure 4). More than two out of three electrical fires in industrial buildings were due to technical faults. A technical fault was a particularly common cause for fires in industrial buildings, with a proportion of more than 80%. Public halls had relatively a little fewer technical faults than business premises. However, this difference may be explained with the growth in the proportion of unknown causes. In office buildings, technical faults were dominant with a proportion of clearly more than 80%, while the proportion of incorrect action or use was 6%. The most common causes for electrical fires in health care buildings also included various technical faults, but it is important to notice that the proportion of incorrect action or use was 38%. The situation in educational buildings was very similar to that in health care buildings, where the proportion of incorrect action was emphasised.

Agricultural and industrial buildings differed from the other types of buildings with clearly higher damage (table 1) and with the highest relative proportion of major electrical fires. The damage costs were lowest in office buildings. The damage costs in dwelling houses were highest in terraced houses. They were lowest in apartment houses.

Review of time and location

It was found that the time of the day and the municipal population density