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# Fire safety engineering applied to the domestic chip-pan fire problem.

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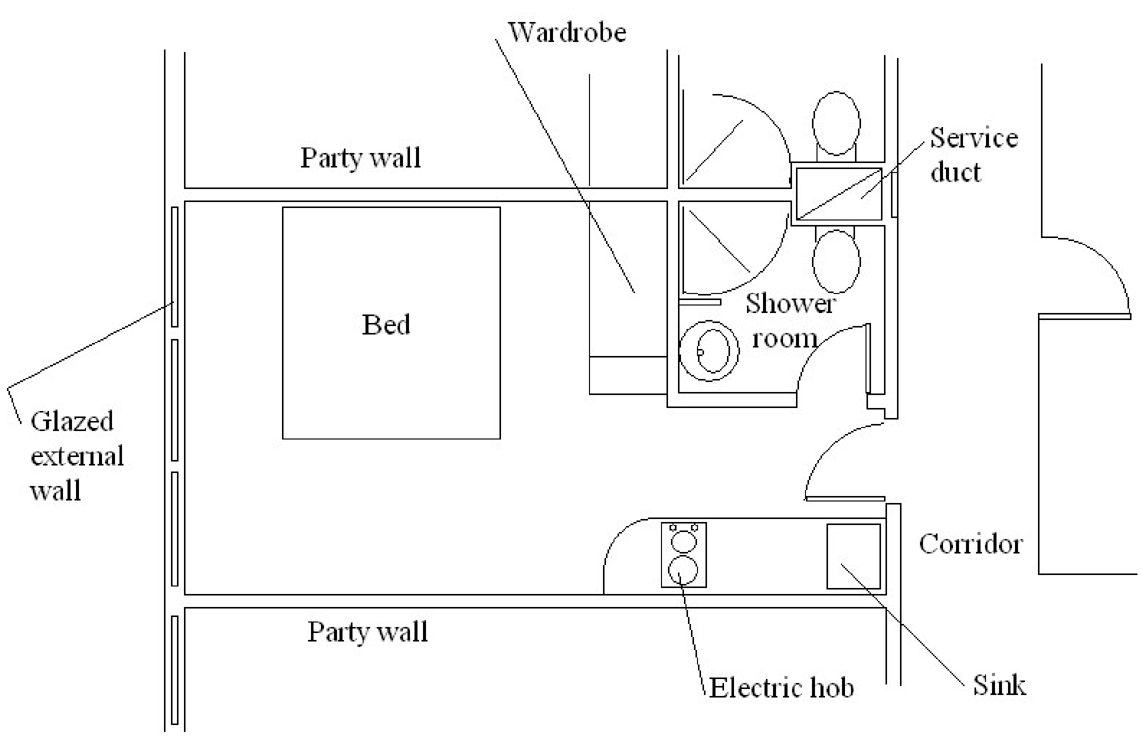
## The problem

For many years chip-pan fires have been the cause of disfiguring injuries and deaths and damage to property, and the government recognizes this in a current campaign to reduce them. There are approximately 4000 accidents and 130 deaths caused by chip-pan fires in the UK reported by the fire service each year and these casualty statistics do not include fires not attended by the fire service. Such a fire, which can be a frightening phenomenon, can be made far worse if water is thrown onto it in an attempt to extinguish.

An electric hob had been installed near the narrow single entrance/egress doorway in each of the 80 flats in a 5-storey hostel in North London managed by a local authority,




*Typical room plan showing location of hob*

The planning of the individual rooms did not follow implicit guidance in Approved Document B or the Home Office Guide to Means of Escape and related Measures in certain existing Houses in Multiple Occupation (HMO's) which recommends that areas of highest fire risk (kitchens for example) are placed as far away as possible from the fire exit door which is also the flat entrance door in the hostel. It would be difficult and very hazardous for occupants to escape past a hob if a chip-pan fire occurred. The author was commissioned to consider and mitigate the risk. It was paramount that any remedial work would minimize interference as all flats were occupied

***Test on unmodified hob with both hotplates at maximum power after small amount of oil was poured onto centre of hotplate. A major spillage could produce a chip-pan fire***

**Options**

Several options were considered as follows. The preferred option would form part of a package of improvements to the fire precautions systems and management:

1 Leave the planning and installation arrangements as they were. There was a consensus among the approving authorities (building control, environmental, housing and fire officers) that this was unacceptable.

2 Relocate the hob away from the entrance. While this placed a possible chip pan fire away from the entrance it unfortunately introduced the every day hazard of having to carry hot cooking utensils over to the work surface and sink some distance away.

3 Install an automatic powder dump extinguisher immediately above the hob. Problems were cost and space but, more importantly, a chip pan fire so extinguished could spontaneously ignite some time after the powder had done its job.

4 Install a portable powder extinguisher and a fire blanket in each room, and provide instructions to tenants what to do in event of a fire i.e. extinguish the fire with the powder and immediately cover the pan with the fire blanket and leave covered for several minutes so that the oil drops well below its auto ignition temperature - official advice on

chip pan fires is to leave the blanket in place for 30 minutes. This option was considered unacceptable as it depends on a high state of consciousness and motivation which occupants may not have due to intake of drugs or alcohol. Also the use of pressurized extinguishers used too close to a fat fire could aggravate the fire.

5 Leave the hob where it was and provide a portable, fully enclosed chip fryer with instructions to tenants to use the fryer, but this would not prevent lesser frying operations e.g. frying in a shallow frying pan on the hob. Would the chip fryer ever be used?

6 Install a low-pressure water mist fire suppression system immediately above the hob connected to the water supply. This would be expensive and the mains pressure would not be high enough (it would probably need to be around 5bar).

7 Install fusible-link-actuated fibreglass roller fire curtains to the front and sides of the hob so as to enclose it. There was no space and, anyway, the curtains would be costly to install and maintain. Further, in descending, they could tip over a pan. They would only provide a flame barrier and have no fire suppressing function.

8 Rely on automatic smoke detection to warn the occupants before a flaming fire could occur, but this option could cause many general false alarms because of detector sensitivity unless a stand-alone smoke detector was fitted in each room. A stand-alone detector would require the battery to be regularly checked for charge or presence (it might be removed because the alarm was causing a nuisance or because the battery might be useful for some other purpose). Heat detection could not be relied to give an alarm early enough.

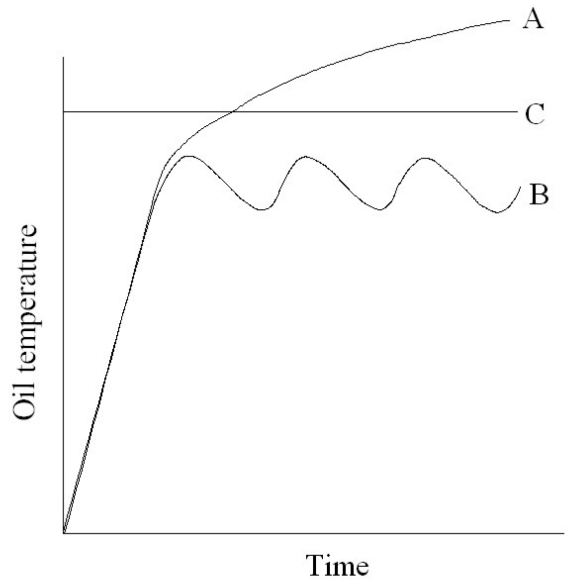
9 Leave the hob where it was and modify the heating controls to both hot plates so that it was impossible to produce a chip-pan fire but still be able to cook chips and undertake water-based cooking.

Option 9 was eventually chosen as it was thought technically and commercially feasible using an arrangement of carefully positioned thermostats and fuses frequently used in other cooking appliances.

**Thermostatic versus energy control**

It was clearly unacceptable to have a hob which, if left switched on, continued to heat the pan contents as shown in curve A in the diagram, for once the temperature went above the danger temperature, point C, fire could occur. The present hob operated in this way. Thermostatic control, indicated by curve B could, on the other hand, prevent ignition irrespective of time duration. It was surprising to find that no thermostatically-controlled domestic hobs were on the market in the UK though there were hotplates for laboratory use.

Before developing a system of thermostatic control it was necessary to specify some scenarios. But first a brief note on the properties of cooking oils. Information on the ignition of cooking oils was collected to quantify the autoignition temperature or hot surface temperature but it is not appropriate to give it here. Generally it can be said that the maximum temperature to which cooking oils should be raised for proper cooking is around 200 -250$^{o}$C. Differences between the ignition temperatures of various types of cooking oils and fats were said to be trivial, but the current range of product was tested in the hob development work in order to be sure.




***Difference between energy and thermostatic control***

**Scenarios**

Worst case scenarios were identified. It was considered that a fire should not result from

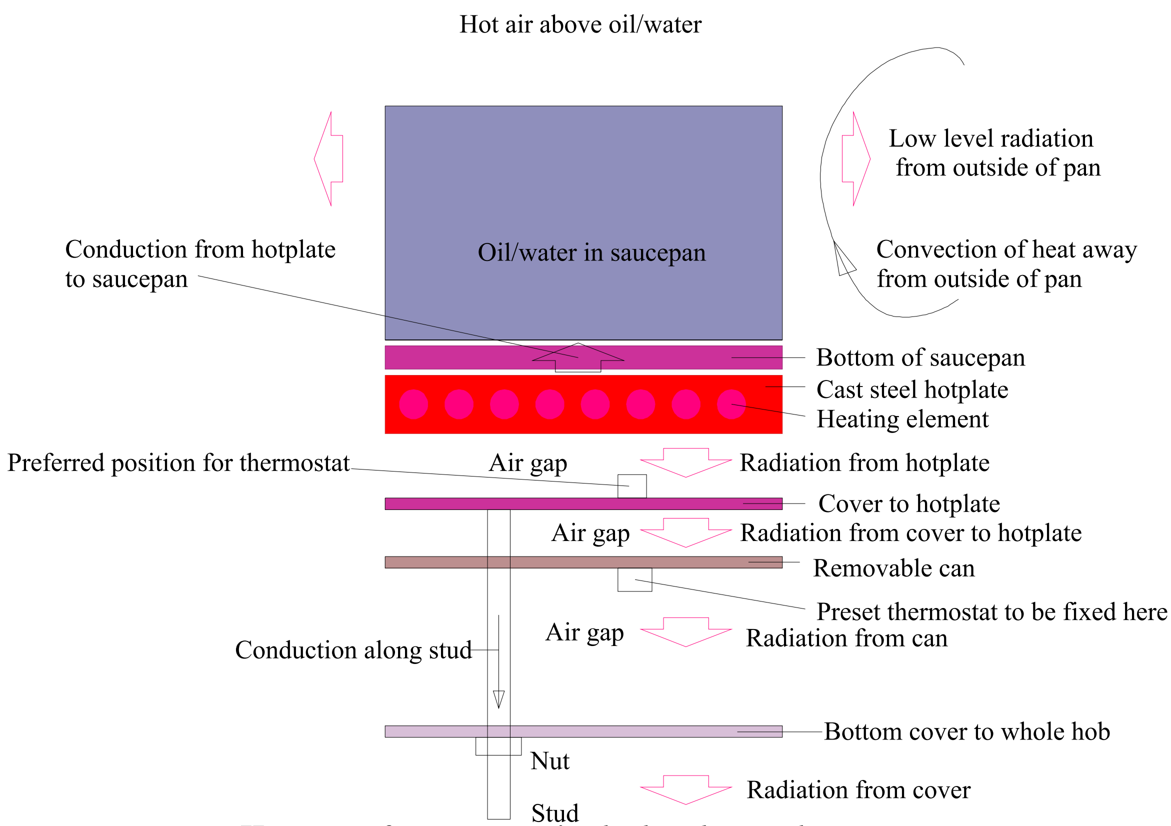
- leaving a small or large amount of oil in a pan on either hotplate for several hours
- dumping wet or dry chips into the oil when the oil in the pan was at its highest temperature such that overflow onto the hotplate occurred
- spillage of hot oil onto the hotplate immediately upon removing the pan from the hotplate
- any of the above conditions when both hotplates were in use and one hotplate was bare or in use
- placing a wad of folded newspaper or dropping a piece of paper towel or a linen tea towel or a plastic cup onto a bare hotplate when at its highest temperature – these were included at the suggestion of the fire officer although it was accepted that this was a less important scenario as the hostel had a smoke detector installed in each room and this would be expected to warn occupants of a smouldering fire, and massive flames sufficient to bar the exit could not result from this scenario.

**Heating tests**

Tests were first carried out on one of the energy regulated hobs already in use in the hostel. This showed that a chip-pan fire was easily achieved, Photo, as the hob continued to heat the oil well above its ignition temperature. For safety and environmental reasons the tests were done by spilling small amounts of oil onto either of the two hotplates when at maximum setting on the hob controls. Temperatures were measured with digital thermocouples and an infrared digital thermometer. Thermostatic control was clearly needed and the Italian hob manufacturer was asked, via the importer, to produce a prototype hob with this form of control. Three months later the new hob arrived, it was tested and it was then discovered that the hob simply had hotplates with lower power ratings fitted but did not have thermostatic control. A search was made for a UK specialist design and development company with in-house test facilities to help take the work forward and, as a result, Destech UK became involved in the project.

The strategy was to modify the existing hobs by adding thermostats and fuses which resulted in the required temperatures of the cooking medium (oil or water), hotplates and other parts of the appliance which just enabled chips to be cooked while also allowing normal water-based cooking. The choice of thermostat had to take account of phase lags in heating and cooling processes, and also by what thermostats were available in the market, and this choice was not easy. Further they could only be positioned where they would not invalidate warranties and continue to satisfy the relevant British Standards

Although the heating rate up to thermostat cut off point was within control using the energy regulator fitted (represented by six heat switches) it was not possible to influence the rate of cooling in each on/off cycle as it was a natural phenomenon and depended on what, if anything, was resting on the hotplate..




***Heat transfer processes in the hotplate and pan***

Furthermore the choice of operating temperature of the thermostats could not be tuned too finely as there was a lag between the heating of the heating element embedded in the cast steel hotplate and the heating of the oil. The heat transfer processes were complicated, as shown in the diagram, and of course the diagram does not indicate time-based phenomena such as phase lag. The proving tests were done on a spare hob both in the test laboratory and in the hostel

***Inside of inverted hob with bottom cover removed. The white energy regulators are at bottom of picture.***

**Conclusions**

An electric hob has been successfully modified, using commercially available parts, to produce a fire-safe hob. It proved possible to boil water within a reasonable time on both hotplates though vigorous boiling was not maintained over the short period when the hotplate was naturally cooling in each cycle. More importantly it proved possible to cook chips safely and for hot animal or vegetable oil to be spilt onto either hotplate without causing a fire. However a hotplate, after it had reached its maximum temperature, could cause smouldering ignition of a thick bundle of newspaper but it was agreed this was acceptable. Ignition of thin paper or a plastic cup did not occur. All 80 hobs in the hostel have now been replaced with the modified hob.

There is a management issue associated with the hobs in hostel-like situations. It appears that if a tenant uses the hob as a space heater to supplement the conventional room heating, the hob will fuse after several hours of continuous operation at maximum setting on both hotplates when left bare. The hob will not fuse when used for normal cooking operations. Such misuse of the hob would shorten the life of the hob and new users need to be warned against this practice.

There are nominally 11,000 chip pan fires in the UK each year and these result in more than 4,000 injuries and 30 fatalities a year. It does not need much imagination to see that the use of a fire-safe hob in hostels and other residential buildings could do much to reduce the casualty toll, especially where reliance is on electric cooking devices to avoid gas-related problems such as explosion.

End of article