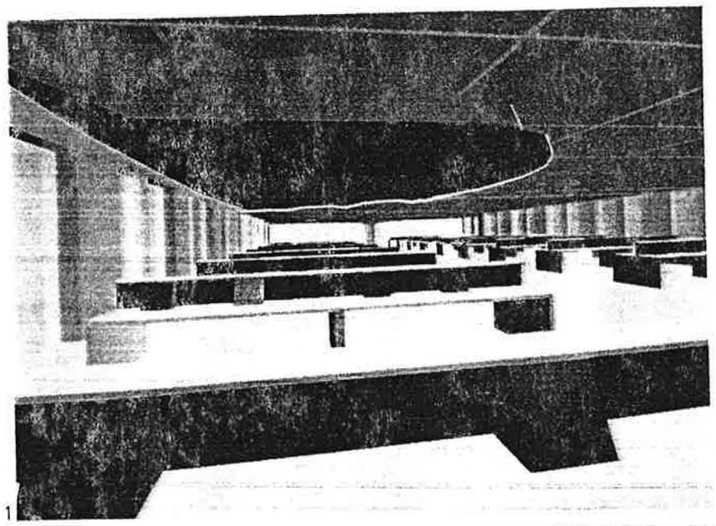
C1/Sfb (K2)(35)

Fire spread in cavities
Model behaviour

Fire-barrier requirements in above-ceiling spaces have been relaxed in the new Building Regulations. **Anthony Ferguson** explains why, and looks at the computer modelling involved.

The greatest danger in a fire is not the flame but the smoke and gas. If these spread through the building, people well away from the fire itself may not be able to escape because they cannot see or breathe properly.

The Building Regulations recognise this problem and ask for barriers in cavities to avoid the unseen spread of smoke and fire.



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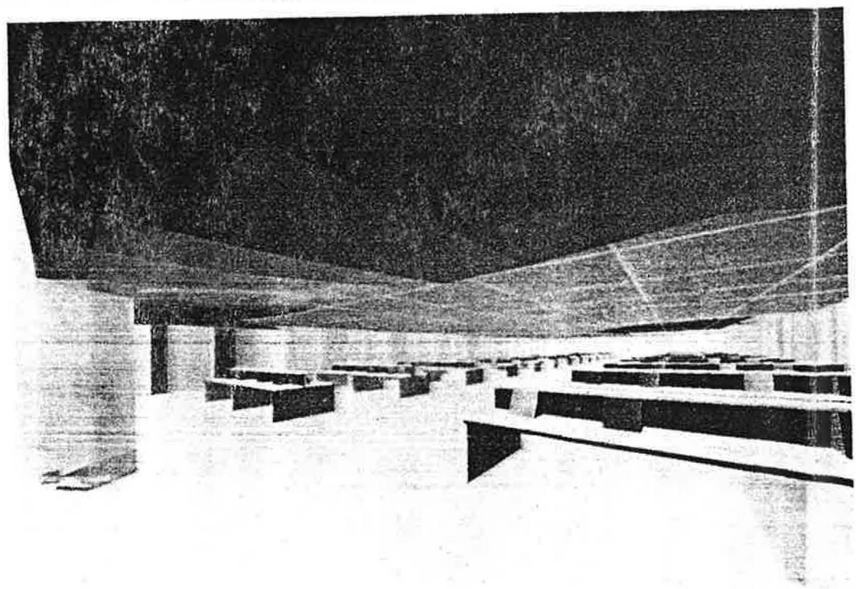

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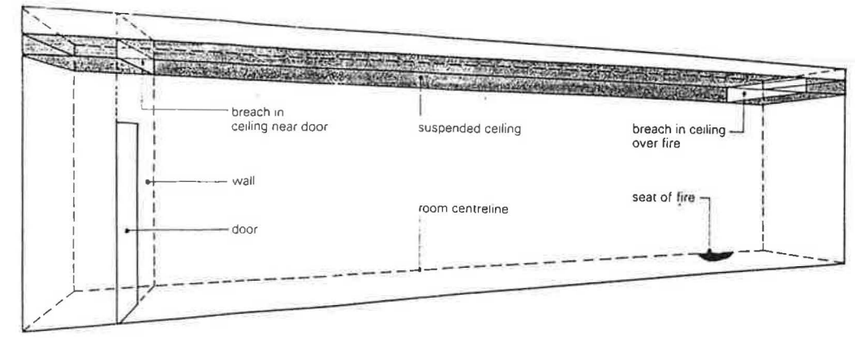
1,2 Two screen images from the fire modelling, shown in more detail overpage. In 1, the cut-away ceiling shows the smoke front advancing within the ceiling, ahead of the smoke below the ceiling (the plume of smoke rising from the fire is in the centre at the back of the room). In 2, from the opposite end of the room, the fire is the 'column' on the left with smoke spreading across the ceiling surface.

The 1985 regulations used the measures developed in the aftermath of the fire at the Fairfield old people's home in 1974 (see AJ 1.5.85 p63).

Yet for some years there has been debate about how relevant the cavity barrier prescription is to the suspended ceiling cavity over a large room. Heavily serviced ceiling voids over many open-plan offices are not easy places to insert cavity barriers. Under the 1990 Approved Document for England and Wales, barriers are needed at 20m intervals. All service penetrations of those barriers have to be fire stopped and ducts fitted with dampers.

The Department of Environment's advisory committee on the regulations helped shape the new Part B Approved Document on fire safety. It suggested that smoke spread in cavities over large rooms might not be such a problem as in a cavity that spanned several small rooms. Because you can see across a large room you would know very quickly if a fire had started. But the experts could not agree whether or not smoke from a fire that got into the ceiling void would spread more quickly there than below the ceiling. If it did, there was a risk that the fire could emerge at a point between the occupant and the exit before the danger was appreciated. The fire service, for example, has reports of fires spreading unseen in ceiling spaces over the heads of the firefighters, who suddenly find themselves in danger of being surrounded.



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3 Key diagram to figures 4-7. They show modelling of half a room — the symmetrical half is beyond. Here is a worst case, breaks in the ceiling above the fire and at the door.

4-7 Fire spread at four, six, seven and eight minutes. The contours represent the boundary of thicker smoke (visibility 20m) representative of significant obscuration for escapers and firefighters. In 4, the volume enclosed between contours and ceiling represents the thickest smoke. Above the ceiling the front of thick smoke is advancing from right to left faster than that below. In 5, smoke arrives first via the ceiling void but not in significant quantities. In 6, smoke under the ceiling spills down to the floor adjacent to the door. In 7, there is some obscuration from floor to ceiling from the door area back towards the right where the fire seat is located. However, this is not a serious hazard and does not occur too rapidly to impair escape.

A model approach

The Fire Research Station of BRE was asked to investigate. It ran a computer simulation of the problem using its Jasmine computer model. The results gave the DoE the information needed to alter the guidance in the Approved Document.

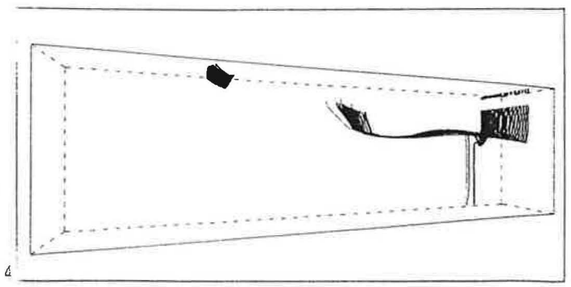
The room modelled was a large open-plan office, such as a dealing room. It was 50 x 20 x 3m high. It examined ceiling cavities of 0.5m and 1.5m and several different fires ranging from small ones of constant size to one which grew exponentially, doubling in size every three minutes. It was assumed that there was a hole in the suspended ceiling over the fire and that there were also breaches in the ceiling at the far end of the room where the exit was presumed to be. This worst case assumption gave the smoke an easy route across the room above the ceiling and down again into the room.

A sequence from the simulation shows how the smoke spreads above and below the ceiling. The contour lines describe the surface which marks the boundary at which visibility drops below 20m; above those lines the smoke is more dense, 4-7. At about six minutes into this fire, in which it was assumed there were no cavity barriers, smoke in the ceiling void had travelled ahead of the smoke moving under the ceiling and had begun to blow down from the gap in the ceiling at the far end of the room.

The perspective view, 2, is a view from a point near the fire (the grey column on the left) looking at the layer of dense smoke advancing under the ceiling. Representing the same stage but seen from the other end of the room, 1, the ceiling is cut away to show the smoke front in the cavity well ahead of the under-ceiling stream, just visible as a black fringe in the background.

Several runs using different conditions showed that smoke could travel more quickly in the ceiling void, but that the smoke build-up near the door, which was not itself a severe hazard, only occured well after the room was likely to have been evacuated.

Without this evidence, obtained at a fraction of the cost of setting up a real fire test, it would not have been easy to justify a relaxation of the Building Regulations guidance.□



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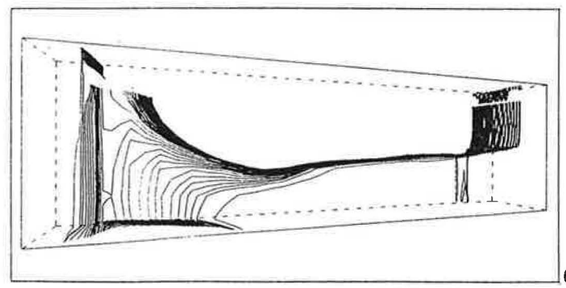

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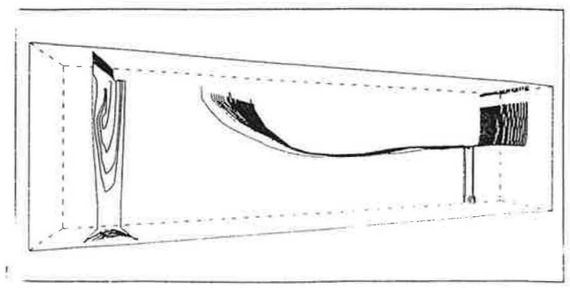

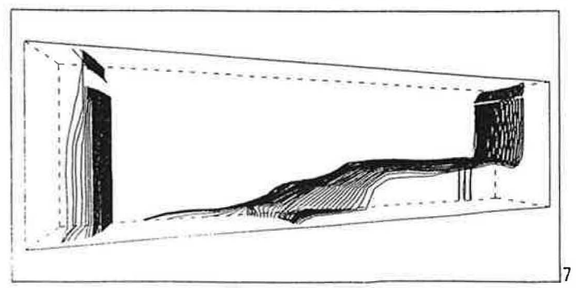

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