

Gothenburg dance hall, Sweden, 1998

- The fire occurred on 28 October 1998 in a crowded dance hall in Gothenburg.
- 63 people died, 120 were injured and about 60 were rescued by the fire brigade.
- The hall had about 400 people present at the time of the fire but it was only authorised for 150 people by the local fire chief.
- The fire started in chairs which had been stored in one of the two escape staircases.
- Four young boys were convicted of murder one and a half years after the fire



Gothenburg – fully developed fire.

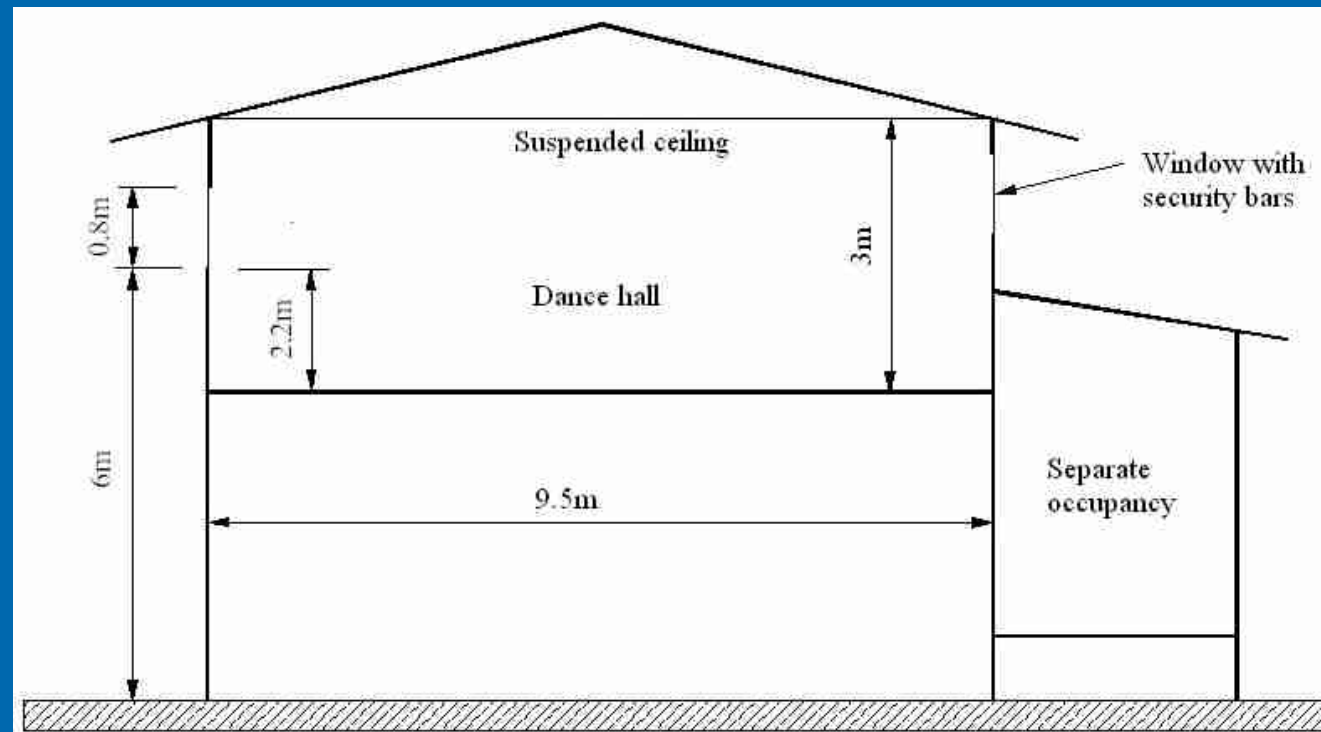


Gothenburg dance hall in use



- Typical use of hall before the fire. Note the low ceiling and down-stand beams
- On the night of the fire the hall had been rented for a Halloween party by high school students. It was so crowded that it was impossible to dance.

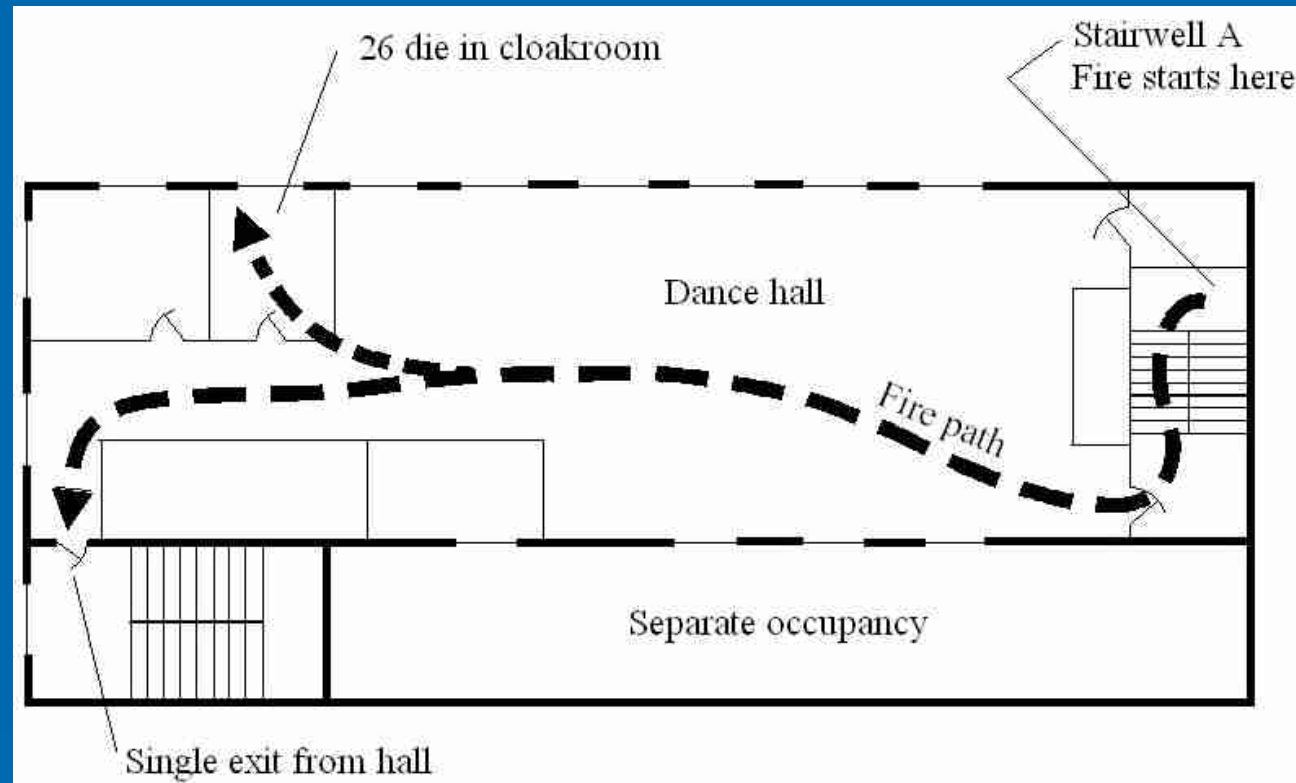




- The building was two-storeys high and the dance hall was located on the upper floor.
- The hall was 32 m long by 9.5 m wide with a ceiling height of only 3 m.
- The construction of walls, floors and pitched roof was of concrete, but there were combustible decorations hanging on the walls and from the suspended ceiling of the hall – this ceiling comprised glass fibre tiles with a painted surface.



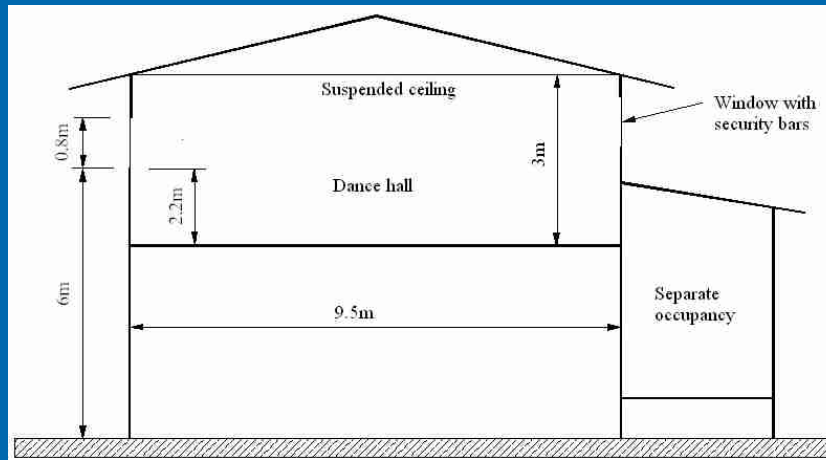
Dance hall - fire route



- There was an exit served by a dogleg staircase at each end of the hall, hence there were two well-positioned escape routes provided as required.
- The stairwell (Stairwell A) in which the fire occurred was made of brick and concrete.
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- The doorways onto the stairs were 800 mm wide and opened in the direction of travel; the stairs were 1.5 m wide.



Gothenburg – building features



- There were eight breakable windows on one face of the hall but only 6 of these opened directly from the hall and five of these were, fortunately, above a single-storey adjoining roof.

- The windows on the other long wall had been fitted with steel bars for security.

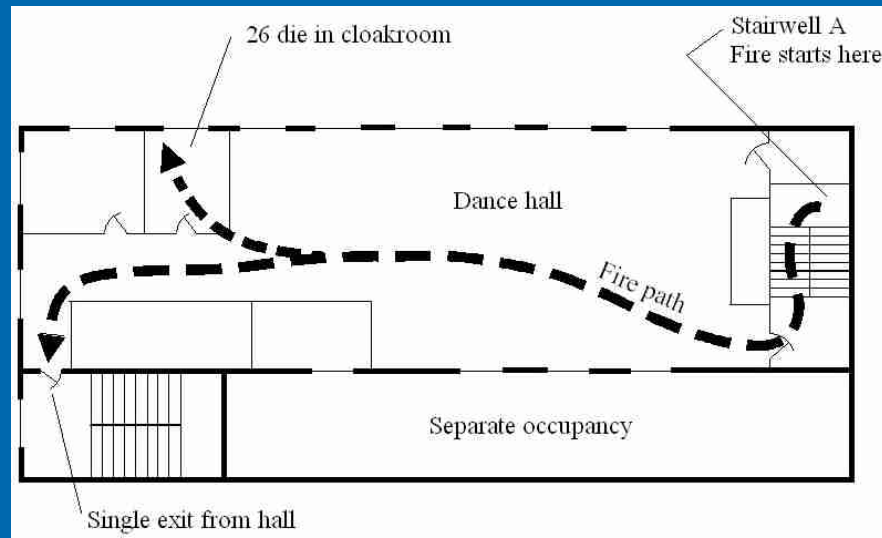
- The lower parts of the hall walls were lined with a combustible timber veneer.
- Tables and chairs were upholstered in combustible materials.
- There were no automatic fire suppression or fire alarm systems installed in the building.
- There were illuminated exit signs at each end of the hall.



Gothenburg – the hazard of fire fighting



Gothenburg – the fire



- The fire started on the lower landing of Stairwell 'A' which had been used temporarily to store about 40 stacked chairs
- The fire was discovered when the disc jockey opened the door to the staircase.



Gothenburg – the fire

- The DJ phoned the fire brigade on his mobile phone and, realising he would not be able to get to the other staircase to escape, broke and jumped through a window onto the adjoining roof.
- When the door to the discotheque hall was opened toxic smoke, and soon after flames, spread into the hall, and the linoleum floor covering became ignited due to radiation from the hot ceiling gas layer.
- The students tried to get out through the one remaining exit while 26 youngsters took refuge in a cloakroom near the exit, but the fire broke through the glazed area above the partition and those occupants died by smoke inhalation.



The hall after the fire



- Below the green star is the door from the staircase. Fire in staircase burst into the hall when this door was opened by DJ
- Fire has consumed all combustible material in the room including floor coverings. Remains of stage is at left hand side.



Gothenburg dance hall fire research

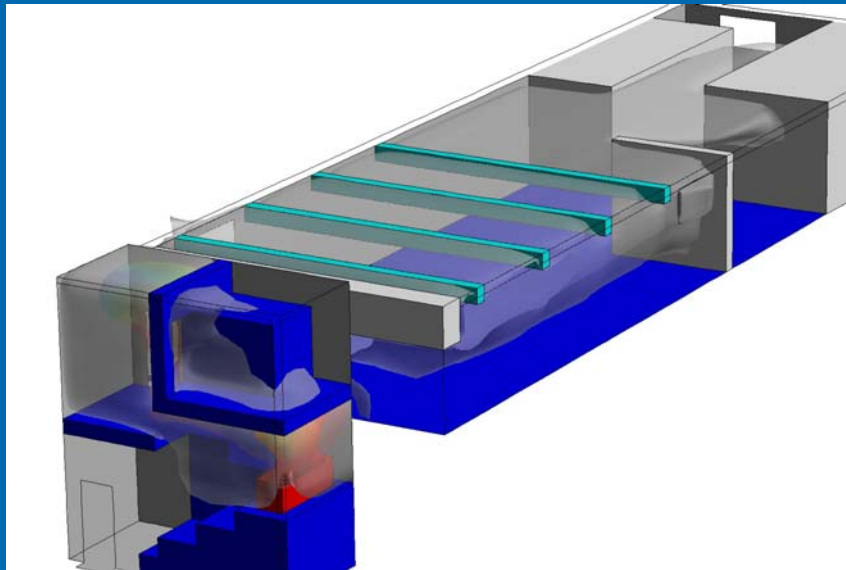
- SP, The Swedish National Testing and Research Institute of Sweden, was brought into the investigation by the police Department of Vastra Gotaland to find out *exactly where, when and how* the fire started. It carried out a number of tests and computer simulations. Some of these are summarised below.



- SP constructed a quarter-scale model of the discotheque and made 13 fire tests therein which involved the use of timber cribs as the fire load
- In Sweden, fire tests in scaled models had not previously been used. The real staircase and model staircase in which the incipient fire occurred are shown here.
- The aim was to get the same maximum rate of heat release in the model and full scale condition. 40 chairs were estimated to produce 4000 kW in 20 minutes, corresponding to a maximum rate of heat release of 125 kW in the model at 10 minutes.



SP fire modelling



- The fire has been numerically modelled by SP using computational fluid dynamics (CFD). The CFD simulations were made using the SOFIE (Simulation Of Fires In Enclosures) software.
- This 3-dimensional graphic shows a smoke and heat condition at a particular time (10 minutes after ignition), one of many conditions simulated, after the door to the hall was opened.

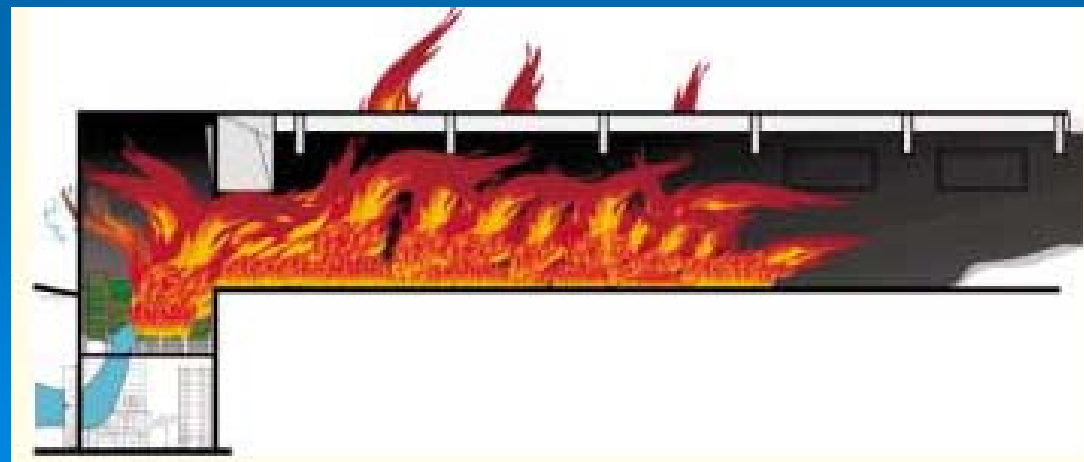
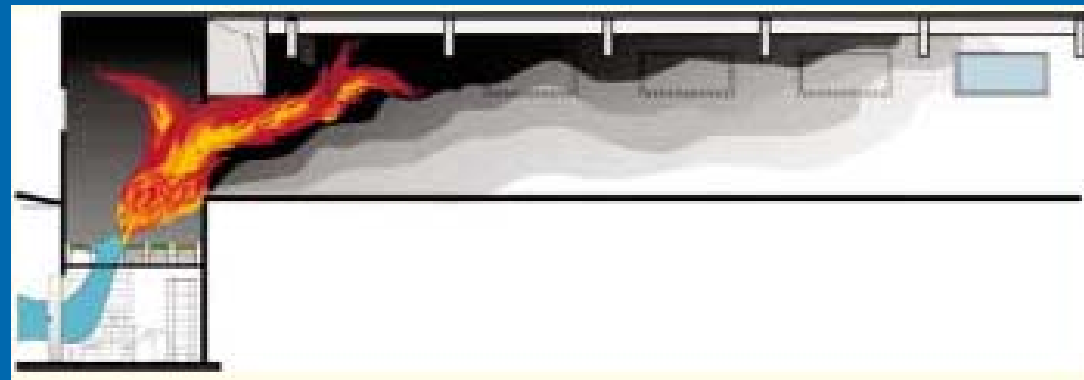


Gothenburg fire simulation.

upper diagram - 2 minutes after ignition

lower diagram - at flashover

Note ignition of plastic floor tiles



Gothenburg – predicted time line



- Having conducted the programme of fire tests and modelling SP were able to predict the course of events as follows:
- 23.30 approx. Fire in stairwell started maliciously
- 23.42 Door between stairwell and hall opened and left open
- 23.44 Smoke has spread to other end of the hall, students try to escape from second exit
- 23.57 Fire is fully developed in hall and flames are jetting out of windows, radiation and flames are sufficient to ignite the eaves of the Backa theatre 5 m away
- 24.30 Door at foot of stairwell closed
- 02.00 approx. Fire out



Gothenburg – observations

- Combustible furniture had been stored in one of the escape staircases. This violated the fundamental rule that all escape routes should be kept free of obstruction and fire load.
- Fire was started with an incendiary device.
- There was overcrowding in the hall and the remaining single escape route could not cope with the large number of people: there were perhaps as many as 400 students in the hall whereas the hall was only permitted to have 120.
- There was no fire alarm system and therefore no warning that fire had developed to a serious stage in the stairwell.
- Doors to the stairwell did not have self closing devices fitted
- The windows could not easily be used for escape as the window ledge was 2.2 m above floor level.
- Unfortunately the coincidence of opening the door into the hall at the time when the fire on the stairwell was well developed but unseen resulted in rapid spread of smoke and hot gases into the hall, helped by a plentiful supply of air through the open door at the foot of the stairwell.



Gothenburg – observations

- The low ceiling in the hall meant there was no beneficial smoke reservoir in the hall
- The unusual contribution to fire spread by the floor covering could be explained by the low thermal inertia (kPC) of the fibreboard and linoleum which formed the hall floor covering.
- Modelling the fire showed without doubt how the fire had started and why it spread so rapidly. This placed great responsibility on the modellers as their findings contributed to the verdict of murder given to the four boys who started the fire.
- The ignition and fire growth tests showed that, while it may not be possible to ignite an item with a match, using a larger fire source together with a stacked configuration of chairs led to a severe fire. This should be a lesson to those who sell their product or approve the products of others by reference to misleading ad hoc tests using an unrepresentative small heat source.
- The chairs only burnt when they were stacked on top of each other – a finding reflected in other studies

