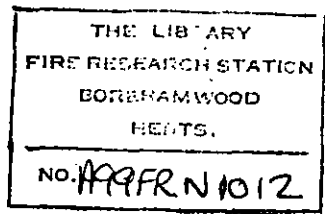




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**THE FIRE PROBLEMS OF PEDESTRIAN PRECINCTS - PART 5
A REVIEW OF FIRES IN ENCLOSED SHOPPING COMPLEXES**

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THE FIRE PROBLEMS OF PEDESTRIAN PRECINCTS - PART 5
A REVIEW OF FIRES IN ENCLOSED SHOPPING COMPLEXES

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SUMMARY

This Note describes a number of fire incidents in enclosed shopping complexes and some other buildings also used for retailing. Factors common to different fires are compared. The fires described occurred in the USA, the UK, Canada and Mexico.

The worst hazards are noted and suggestions are made as to how these may be overcome.

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THE FIRE PROBLEMS OF PEDESTRIAN PRECINCTS - PART 5
A REVIEW OF FIRES IN ENCLOSED SHOPPING COMPLEXES

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1. INTRODUCTION

Large buildings enclosing numbers of retail premises usually connected by covered pedestrian malls or arcades have multiplied considerably since the Second World War, particularly in North America. A number of disastrously large and expensive fires have occurred in this type of occupancy, many of them in the United States, but others in Canada, Mexico and the United Kingdom.

A survey of the available literature¹⁻¹⁵ has been undertaken and a total of 128 shopping centre fires listed, covering a period from 1949 to 1971, it is however uncertain how complete the list is for the four countries mentioned above. Some 67 fires have been more fully reported and of these 18 were considered to be of special interest and are summarised in this Note which also aims to state what conclusions can be drawn and lessons learned from fires in this type of building.

Six of the fires described were not strictly in enclosed shopping complexes but they are included either because they occurred in buildings with similar fire hazards or because they highlighted some point to be borne in mind when designing or managing future shopping centres.

2. SURVEY OF INDIVIDUAL FIRES

2.1 General

Of the 18 fires briefly described, 11 occurred in the United States, 5 in the United Kingdom and 1 each in Canada and Mexico.

Each summary given below includes the following details:

- 1) Description of building involved, including details of any sprinklers or other fire protection systems installed
- 2) Brief note of cause of fire at point of origin and how it spread
- 3) Casualties, if any, and problems of escape
- 4) Special hazards or problems for fire brigade and others
- 5) Any conclusions to be drawn from the incident.

Table 1 makes intercomparisons between 12 fires for similar events, as far as this has been possible, for the enclosed multiple shopping centres. Six other fires have been included from occupancies which though not really enclosed multiple shopping areas, do resemble them in some way or have similar fire hazards, and these fires have been compared with each other in Table 2.

2.2 Cleveland, Ohio, USA¹ 23 February 1949

The building comprised mixed one and two storey shopping accommodation with a basement bowling alley. There were 13 shops with 2 arcades extending from front to rear, also an open loft below a wooden roof.

The fire started at some defective wiring during the evening and it spread onto a combustible ceiling which was suspended below the floor above leaving an undivided cavity about 0.4 m high.

All of the occupants were able to force their way out through three exits, barely a minute after the last person had left the main wave of heat and smoke passed by to cut off the exits.

The open loft aided spread of the fire. The only shop which remained undamaged had a fire-resisting wall separating it from the rest.

2.3 New Hartford, New York¹, USA 6 May 1960

The building held 15 shops provided with a continuous canopy.

The fire started in a shoe shop, the cause being unknown. It spread through a combustible partition into a bank but fire-resisting walls prevented further progress. However, smoke spread, by means of hidden spaces inside the canopy, to the other shops.

Four people were injured.

Fire fighting was impeded by an unsatisfactory water supply. The canopy arrangement was considered responsible for the magnitude of the fire damage since it facilitated spread of smoke into all the shops.

This building did not appear to have shops on both sides of a covered mall but the fire is reported here because the canopy in front of a row of shops formed a 'one-sided' mall.

2.4 Houston, Texas², USA 17 October 1961

The building was windowless and contained 17 shops and a stockroom.

The fire was started by an incinerator in the stockroom igniting rubbish.

It spread throughout the stockroom and caused severe smoke-logging in the rest of the building. There were few persons in the building and these were instructed to leave by the public address system.

The brigade were unable to tackle the fire until holes had been cut in the concrete roof to vent the fire beneath. There was a combustible hardboard and gypsum board partition separating the stockroom from the sales area. The brigade were able to prevent the fire from spreading into the sales area but it did suffer considerable damage from smoke, water and heat.

2.5 Pointe-aux-Trembles, Quebec³, Canada 23 February 1962

The building was one storey with basement designed as a motel and later converted partially to shops and other public places. It was not a true multiple shopping complex with covered malls but resembled one sufficiently closely to be included here, for it emphasises venting problems.

The fire started late in the morning and was caused by an overheated deep-fat fryer in a basement snack bar. It spread over combustible cartons in the kitchen, through concealed ceiling spaces, up air-conditioning shafts and stairways to the ground floor and through service pipe openings in store partition walls.

Persons inside at the time of the fire were said to have been able to escape without difficulty.

Fire spread was aided by plenty of concealed spaces and by combustible fibreboard construction. It was vented when the roof collapsed around an air-conditioning shaft, but the fire in the unvented basement was almost impossible to control.

2.6 Chicopee, Massachusetts⁴, USA 12 June 1962

The building was single storey, divided by two fire-resisting walls, between which was a row of six shops.

The time the fire started was not stated but it was probably outside normal business hours. A defective fluorescent-lighting ballast resistor overheated and ignited combustible acoustic tiles on the ceiling in the end shop of the row of six. Burning ceiling tiles dropped onto lightweight dress fabrics in the shops and the fire spread also through an undivided space above all six shops. Gas pipe to suspended overhead heater broke and helped to intensify the fire in the room of origin.

The Fire Brigade had difficulty in venting the fire through a metal roof as well as in gaining access to the concealed space directly over the shops. The fire was stopped by the wall at one side of the shop of origin but spread via the ceiling space to the one on the other side. The remaining four shops were damaged by smoke and water.

2.7 St Cloud, Minnesota¹, USA 31 July 1962

The building comprised shops and warehouse accommodation over an area some 50 by 80 m. It was of fire-resisting construction with single storey and basement, but combustible partitions divided some of the shops from each other.

The cause of the fire was unknown, but it was discovered early in the evening in a basement section of a department store heavily congested with furniture, tyres, paints and thinners, batteries and anti-freeze.

The fire was almost entirely confined to the basement which became badly smoke-logged and also inaccessible.

Call to the Fire Brigade was delayed. Venting of smoke from the basement was difficult due to lack of outside openings, and access via the open stairway and lift shaft was impossible.

The contents of the basement were a total loss. Owing to difficulty in getting rid of smoke the fire took 23 hours to put out.

2.8 Louisville, Kentucky¹, USA 21 June 1964

This centre occupied 13,700 m² shared between ground floor and basement. Half this area had sprinkler protection.

The cause of this fire was not known, it started in racks of periodicals and magazines in a ground floor shop, in the middle of the night.

It spread through combustible wares and interior furnishings in the absence of fire barriers.

There were no sprinklers in the shop where the fire started or in the attic space above it. Canvas screens around some of the shops may have presented a fire hazard but the Brigade extinguished the outbreak in 20 minutes. Three sprinklers were operated in an arcade section by convected heat. A false ceiling of fire-retardant material protected structural steelwork above but did itself require replacement due to heat distortion.

2.9 Fairfield, Connecticut¹, USA 23 February 1965

This two-storey building of brick veneer was converted into a shopping complex.

The fire was discovered early in the morning and started from unknown cause apparently in a piano and organ store.

It spread through an undivided roof space which ran the full length of the building.

The lack of proper fire protection in this building had been pointed out to the owner, who had done nothing to improve matters at the date of the fire. There were no fire-resisting walls, and an abandoned unprotected air shaft provided a further hazard.

2.10 Winter Park, Florida⁵, USA 6 April 1969

This 2-3 storey building occupied almost 19,000 m² (about 2½ acres) between two department stores. This area was divided into four roughly square sections by two enclosed malls crossing at right angles. The shops lining these malls were protected by chain fences or by loose-fitting sliding glass doors for security purposes. Only the two large stores had automatic sprinkler protection.

The fire was discovered early in the morning and had been burning for some time, it appeared to have started in one or other of two shops facing one of the malls, the cause being unknown.

It spread mainly via a large undivided space above the non-combustible suspended ceilings of the shops. Smoke and water travelled readily throughout the malls, shops and department stores due to the absence of any smoke venting or water drainage systems. The smoke problem was alleviated by the collapse of the roof, which vented the fire.

No casualties were reported, but one of the four sections of the shopping centre was destroyed.

The Fire Brigade were hampered by delays in turning off the gas and electric supplies as well as by the delayed discovery of the fire. Lack of protection for steel columns was responsible for the collapse of the roof. Water curtains helped to prevent fire spreading into the nearest department store. The undivided space above the ceilings was the chief factor in the construction which allowed considerable and unobserved fire spread.

2.11 Newcastle-on-Tyne⁶, UK 30 November 1969

The building comprised a department store and shops, of one, two and six storeys. While it was not an enclosed multiple shopping complex it did contain a walkway resembling a covered pedestrian mall and is included here as the fire that occurred in it is particularly interesting.

The fire started early in the evening after the premises had closed for the day.

The fire was caused by an overheated electric motor housed in the chest cavity of an animated manikin made of papier-mâché, cotton wool, crêpe paper, wood wool and draped fabrics, in a window display which included expanded polystyrene 'snow' and other Christmas decorations. Electric fans were left running to provide draughts to turn toy windmills.

The fire spread very rapidly and vented explosively from the display case where it started, to be followed by further rapid spread up six storeys through unprotected floor openings, lift shafts and stairs.

There were no casualties.

In this particular fire there were special problems due to high building density around the site rendering Fire Brigade access difficult. Unsealed party walls, particularly at roof level, aided fire spread. Further hazards were due to flying brands and radiated heat on to shops 18 m away across a road. This fire underlines the risk inherent in window displays containing large quantities of thin combustible materials together with electric motors and fans which produce both heat and draught. The fire also demonstrated extremely rapid smoke-logging of the walkway between display cases, somewhat resembling a covered pedestrian mall.

2.12 Mexicali, Lower California⁷, Mexico 17 December 1969

This fire occurred in a three-storey department store 23 m by 37 m with top storey used for storage only. There was a five-storey hotel at one end and a four-storey office block at the other. Although this building was not strictly an enclosed multiple shopping complex with covered pedestrian malls it has been included here because of its special features and hazards which would be likely to be present in such occupancies.

The fire started early in the evening when a hot floodlight ignited polystyrene 'snow' in a showcase with Christmas decorations.

A back draught explosion occurred when the showcase door was opened, shattering all the glass. Fire spread via adjacent television sets up nearby stairway and also through open doorway into a shoe shop which also formed part of the hotel lobby.

Some 75 to 80 people were in the building when fire broke out, 35 of them employees. Seven persons died, the bodies of six being found only a few metres from some inward swinging exit doors and the remaining body near the stairway. A further 20 persons were injured probably mainly due to jumping out from upper windows.

Panic was caused by failure of the normal lighting and the lack of any emergency lighting. There was delay in calling the Fire Brigade and fire spread easily up the stairways and through openings. Some of the exit doors opened inwards only and this fact, combined with the lighting failure and smoky conditions probably helped to cause the state of panic among persons trying to escape and the seven deaths.

2.13 Dallas, Texas⁸, USA 21 December 1969

The building was a single storey shopping centre with sprinklers fitted in the arcade and in a few of the shops.

The time the fire started is unknown but it was probably outside normal business hours. It was probably caused by faulty wiring in a shoe shop. There was rapid spread through combustible wares and wood stud partitions to five shops. Sprinklers then confined the fire until the Brigade arrived.

There were no casualties.

Some plastic domelights in the roof melted away and assisted in the removal of smoke. Complete sprinkler protection would probably have confined this fire to the shop of origin.

2.14 Plymouth, Pennsylvania⁹, USA 10 January 1970

The building was approximately 100 m by 200 m comprising a central corridor with shops both sides and a large department store at each end, there were two storeys and some 110 shops, three of the largest of which had sprinkler systems. There was also a manual alarm system and hoses.

The fire started in the morning and was thought to be caused by a wiring fault beneath a showcase in a clothing shop.

It spread rapidly across combustible decorations in the showcase and into the shop through a window broken by the heat.

No casualties occurred. All persons inside were able to make their escape.

Fire spread was aided first by a considerable delay in calling the Fire Brigade and then by the fact that difficulty was experienced in shutting down the air conditioning system which was supplying fresh air to the fire and helping to spread smoke throughout the building. On arrival the Fire Brigade encountered heavy smoke-logging. (There was no venting system). It would have been helpful to have had better means of sealing off individual shops from the arcade and also to have had better drainage to remove sprinkler and hose water. A water curtain in front of one shop prevented the glass from breaking and also serious damage.

2.15 Salisbury, Wiltshire¹⁰, UK 21 February 1970

The building comprised a shopping precinct of 50 to 60 shops on one storey with some multi-storey development at each end. Some of the shops had sprinklers fitted but not the one where the fire started.

This fire was a proven case of arson, it was started shortly after midnight in a toy shop well stocked with plastics goods and packing materials.

No casualties were reported.

The Fire Brigade encountered a fierce, prolonged and exceptionally smoky fire, due to the quantities of plastics involved. The visibility in the arcade between the shops was said to be nil, but it must be remembered that this was at night. Access for firefighting at roof level was impossible owing to stairways leading down to the shops acting as flues for smoke and hot gases, the Brigade therefore had to attack the fire from the arcade and shop fronts.

The shops faced on to an open courtyard so that this was not really an enclosed centre but it has been included here as it shows how smoke-logging can occur even with non-enclosed shopping precincts.

2.16 Wulfrun Shopping Centre, Wolverhampton¹¹, UK 24 December 1970

The centre comprised a curved arcade about 85 m long with shops both sides and single storey. Only one shop, a department store, had a sprinkler system.

The fire probably started during the night or even the preceding day but it was first noticed early in the morning. The cause of this fire, which started in a carpet store, remains unknown.

It spread into the arcade and damaged three shops opposite the carpet store which itself was burnt out.

No casualties occurred.

It was fortunate that the fire started in a shop which was near to the open part of the arcade so that considerable venting of flame and smoke occurred which made it possible for the Fire Brigade to tackle the outbreak. Even so there was heavy smoke-logging in the arcade on the side of the fire remote from the section of the arcade which had an open roof. A screen under the roof acted as a barrier to the spread of flame, and to a lesser extent to the passage of smoke. The resistance of some glass to cracking showed that it is useless to rely on this as a means of venting a fire.

2.17 Newcastle-on-Tyne¹², UK Mid 1971

This centre consisted of two intercommunicating four-storey buildings about 27 m by 21 m overall area; thus it was not a true purpose-built enclosed shopping complex but it resembled one sufficiently closely to be described here.

The cause of the fire was unknown, it started during the morning, the Fire Brigade being called at 11.18.

It spread very rapidly in stores filled with foam rubber and foam polyurethane cushions, polystyrene tiles and plastic handbags. The building was stated to be smoke-logged within five minutes of the fire being discovered.

No escape problems were reported, the people in the building being able to get away without any casualties.

Fire Brigade access was difficult because of the congested site of the building, they were further handicapped by extremely dense smoke from the burning rubber and plastics.

The fire underlines the hazards of storing large amounts of lightweight plastics materials in which fire will spread rapidly and produce very dense smoke.

2.18 Portsmouth, Hampshire¹³, UK 9 December 1971

This shopping complex covered 93,000 m² (23 acres) and was partially covered, consisting of rows of shops with covered malls in between, open at the ends. At the time of the fire some of the shops were still unlet and empty.

The fire was probably caused by overheated wiring at an electrical distribution board in a clothing shop, it started in the middle of the night, when only a security guard was present.

Fire spread throughout the shop of origin on one side of a partition with opening, then into covered malls on each side and partly into shops on their far side. Severe damage to concrete columns occurred in the clothing shop.

There were no casualties.

It was fortunate that one shop which communicated through to a third arcade was empty at the time of the fire thus preventing further spread in that direction. Also the Fire Brigade were able to attack the fire from several entrance points. In spite of this they commented on severe smoke-logging beneath the roofs due to lack of external wind.

2.19 Edison Mall, Fort Myers, Florida¹⁴, USA 1972

This centre followed the favoured American design of a central covered mall with large department stores at each end and rows of shops along each side. Here the shops were without solid fronts, having only security grilles which were drawn into place at closing time. However both the department stores had automatic sprinkler water curtains over their doorways.

The fire started in a shoe shop just before it was closed for the night, the exact cause not being stated.

The fire spread rapidly into three further adjacent shops, not via the central mall but via gaps which must have existed in the concrete block walls separating the shops.

No casualties were reported and the few members of the public present were able to leave without any difficulty.

The Fire Brigade were quickly called and arrived without delay, in spite of which breathing apparatus had to be used to enable the fire to be extinguished from inside the mall. Attacking the fire from the rear of the shops was considered unwise as it was felt that this action would have forced the fire into the mall and endangered further shops.

The absence of solid shop fronts makes it highly desirable to incorporate sprinkler protection into each shop, preferably right inside, and even more desirable are roof vents for the removal of smoke.

It was fortunate here that there were no concealed spaces above false ceilings otherwise the fire might well have spread further and been harder to tackle.

3. DISCUSSION

3.1 General

According to a United States survey¹⁵ the larger shopping complexes, those over 37,000 m² area (6.4 acres), appear to have better fire protection than the smaller centres. Only 1 part in 40,000 of the fire loss occurred in these major shopping centres, at least up to early 1966. The same survey states that 75 per cent of shopping complex fires start inside retail premises as opposed to general service areas and public assembly occupancies, and also that lack of sprinkler protection is the largest single factor responsible for large fire losses. United States shopping complexes are often considered to be a high fire risk because they are usually located on city outskirts where fire-fighting facilities are geared to deal with private house fires only.

The majority of the fires described here occurred outside the United Kingdom and it may well be that some of the events would not happen in this country due to our fire and building regulations and recommendations^{16,17}. Nevertheless such fires are reported because it is desirable to emphasise the dangers that could arise if some of the requirements were to be relaxed.

3.2 Spread of fire

Some shopping complex fires have been serious because of the considerable use made of combustible partitions and suspended ceilings, and particularly where piecemeal alterations and additions have been permitted over the years.

The spread of fire is often accelerated by undivided spaces concealed beneath roofs, over false ceilings and inside projecting canopies. Difficulties have frequently been caused by buildings being almost completely enclosed, particularly in basements, so that very little venting of smoke and hot gases could occur.

Large accumulations of thin inflammable materials in retail or storage areas are shown to be a major fire hazard, particularly Christmas decorations, paper, cardboard and plastics, which assist fire spread from a small ignition source. If a fire starts within a showcase the glass sides help to conserve heat in the early stages until the glass falls out or some combustible panel burns through, resulting in a rapid release of hot gases into the surrounding spaces.

A further source of risk is high power lamps, or electric motors, in display cases where the heat generated may build up to an excessive degree, particularly when such equipment is wholly or partly enclosed by a surround of foamed plastics or other materials of low thermal conductivity. Electric fans used to produce wind effects may be a further source of fire spread once ignition or even smouldering has started.

Air conditioning systems may also be a source of trouble, they have been known to transfer smoke from a fire into many parts of a shopping centre that otherwise might have remained habitable.

In many countries the regulations may not permit the extensive use of combustible partitions. In most of the fires reviewed here there were no sprinklers or other automatic fire protection systems in use.

3.3 Escape of occupants

Few escape problems and no casualties were reported for the fires in the enclosed shopping complexes, but only four incidents occurred during business hours and in two of these few people were about. In only one fire were serious casualties narrowly averted.

Less than half the total fires reported here started during normal shopping hours or else during a period when at least part of the complex was open to the public for entertainment, refreshment etc. In these cases the problems of getting people out are of supreme importance particularly in the larger ones where these are more or less totally enclosed. The greatest hindrance to escape would appear to be smoke-logging due to lack of means of venting any fire which occurs. Contributory hazards are lack of sprinkler protection and delayed calls to the Fire Brigade, also the accumulation of combustible materials inside the centre, particularly plastics which produce considerable quantities of dense black smoke when burning and in some cases toxic fumes as well.

In at least one fire failure of the lighting was a major factor in hindering escape and in this case seven persons were trapped in the building and died, most of them being found lying quite near the exit doors but presumably they had not been able to see them in the smoke and darkness.

3.4 Fire-fighting problems

The fires reported show that smoke-logging of unvented enclosures, particularly basements, was the greatest problem Fire Brigades had to face in dealing with shopping centre fires. The other main problem is that due to difficulty of access either because of congested surroundings to the building (ie the two Newcastle UK fires) or because of accumulated wares or rubbish in or behind the shop units. Concealed spaces in lifts and partitions have also been noted as causing difficulty but this problem is by no means confined to shopping centre buildings.

Other difficulties of the Fire Brigades noted were delayed calls, poor water supply and an air-conditioning system which transferred smoke throughout the building.

A further problem in some instances has been the accumulation of water from sprinklers and hose lines, particularly in basements, leading to serious water damage to stock.

4. CONCLUSIONS

An examination of a number of shopping complex and some other fires has shown that the following factors are common to many of them.

- 1) Fires are easily started in rubbish consisting of loosely piled thin flammable materials such as cardboard boxes, textiles and plastics, particularly if these are close to heat sources such as powerful lamps, heating systems and electric motors or fans. Many normal wares in shops are of course both thin and flammable and a further risk is added towards the end of each year with the putting up of Christmas decorations.
- 2) The main causes of fire spread have been seen to be combustible lining materials, the presence of open spaces above ceilings and behind walls only accessible with difficulty to Fire Brigade personnel, and the lack of sprinkler protection.

A glazed showcase can form an ideal place for fire to grow in its early stages with the heat contained until it is big enough to vent itself violently into surrounding spaces.

- 3) The chief difficulty for escaping persons and also for Fire Brigades has been the smoke-logging of unvented buildings, particularly basements. Failure of artificial lighting aggravates the smoke menace considerably. A further hazard exists when shopping centres have been extended at intervals by piecemeal development into a complicated layout.
- 4) Fire Brigade access has sometimes been rendered extremely difficult by congested sites and restricted passage both into and within the shopping centre. The Fire Brigade has also had great difficulty in venting smoke from enclosed buildings.

5. RECOMMENDATIONS FOR ENCLOSED SHOPPING COMPLEXES

- 1) They should be designed so that people can easily escape outside in the event of fire and also so that the Fire Brigade have equally easy access. Unduly complicated internal layouts and piecemeal development of existing buildings should be avoided where possible.
- 2) Adequate sprinkler protection should be provided in the individual shops and any storage rooms.
- 3) Some kind of smoke extraction system should be designed into the building to prevent smoke-logging with a fire, this is particularly necessary for basements.
- 4) Concealed spaces above ceilings and behind walls should be avoided or else provided with effective fire breaks.
- 5) Provision should be made for draining away accumulated water from sprinklers and hose lines either by gravity or pumping, this is particularly important for basements.
- 6) Careful control should be exercised over the use of decorations and the accumulation of rubbish.

6. CONCLUDING REMARKS

At the present time in the United Kingdom the requirements for shopping centres specify full horizontal compartmentation on all floors, non-combustible materials used for construction with control over their surface treatments, sprinkler protection in all shops and storage rooms and means of venting smoke from the mall areas. These should ensure that any outbreak of fire remains localized and without excessive build-up of smoke so that occupants can leave and the Fire Brigade gain access. The fire incidents described in this report show what is likely to happen in the event of non-compliance with one or more of the above requirements.

Table 1. Summary of fires in enclosed shopping complexes

Description of building and spread of fire						Fire-fighting and the aftermath					
Location and date	Size of centre - m	Sprinklers	Estimated time of start of fire	Cause of fire and location of material first ignited	Means of fire spread	Smoke logging?	Special hazards	Fire Brigade problems	Extent of damage		Escape problems, casualties if any and estimated loss
									By fire or collapse	By smoke heat, water	
Cleveland Ohio 23.2.49	150 x 37 13 shops 1 & 2 storey	No	At about 22.00	Defective wiring	Combustible ceiling	-	Undivided loft	Delayed call	-	-	Hindered by inward swinging doors \$1,000,000
Houston Texas 17.10.61	145 x 64 17 shops and stockroom Single storey	No	At about 10.00	Incinerator ignited rubbish on stockroom floor	Rubbish on floor	Of whole building	Rubbish and combustible partitions	Holes cut in roof for venting	Stockroom	Rest of building	Persons escaped easily over \$1,500,000
Chilcopee Mass 12.6.62	120 x 23 6 shops 1 storey	No	Not known	Overheated resistor in fluorescent lamp ignited ceiling tiles in clothing shop	Undivided space above ceiling		Broken gas pipe in shop of origin	Difficult to vent fire	-	-	\$150,000
St Cloud Minnesota 31.7.62	82 x 51 3 shops and warehouse	No	About 18.00	Unknown, in basement	Furniture, tyres, paints and thinners	Of basement	Unvented basement densely packed with combustible wares	Delayed call, difficult to vent fire	All basement	Rest of building	\$680,000
Louisville Kentucky 21.6.64	13,700 m ² Many shops	50 per cent area covered	In the night	Unknown, in racks of periodicals	Combustible wares and interior finishes		Many stalls with canvas covers and side screens		Shop of origin	Much of building	\$130,000
Fairfield Connecticut 23.2.65	86 x 22 2 storey	No	Very early in the morning	Unknown, in piano and organ store	Undivided roof space		Unprotected air shaft, no fire-stop walls				\$800,000
Winter Park Florida USA 6.4.69	19,000 m ² 2-3 storeys	In 2 end department stores	In the night	Unknown, in one of the shops	Undivided space above ceiling	Yes, until roof collapse	Undivided space over ceiling, gas and electric mains supplies could not be turned off for some time	Delayed discovery	c.10 shops or 20% area	Rest of building	Loss not stated
Dallas Texas 21.12.69	1 storey	In arcade and few of the shops	Unknown	Probably faulty wiring in shoe shop	Combustible wares and wood stud partitions				5 shops	Further shops	Over \$250,000
Plymouth Pennsylvania 10.1.70	200 x 100 c.110 shops 2 storey	In 3 largest shops	At about 10.00	Defective wiring ignited showcase in clothing shop	Combustible showcase decorations	Yes	Air conditioning spreading smoke through building	Delayed call	43 shops	Much of building	No escape problems over \$6,000,000
Wolverhampton UK 24.12.70	100 x 50 over 10 shops 1 storey	Only in one large shop	Late in the night	Unknown, in carpet shop	Stocks of carpet, timber ceiling				4 shops	Further 4 shops and arcade	Escape could be difficult Loss not stated
Portsmouth UK 9.12.71	c.60 x 60 c.20 shops 1 storey	No	At about 02.00	Overheated wiring in clothing shop	Combustible wares and fittings	Yes, due to lack of wind		Delayed call	6 shops and 2 arcades	Further 4 shops and arcades	
Fort Myers Florida 1972		In 2 end department stores	Early evening	Unknown, in shoe shop	Via gaps in dividing walls	Yes, to some extent	None	Breathing apparatus required	4 shops	Not known	None loss not stated

Table 2. Summary of selected fires in other types of retail premises

Description of building and spread of fire						Fire-fighting and the aftermath					
Location and date	Size of centre or building - m	Sprinklers	Estimated time of start of fire	Cause of fire and location of material first ignited	Means of fire spread	Smoke logging?	Special hazards	Fire Brigade problems	Extent of damage		Escape problems, casualties if any and estimated loss
									By fire or collapse	By smoke, heat, water	
New Hartford New York 6.5.60	170 x 45 15 shops 1 storey	No	About 19.30	Unknown, in shoe shop	Combustible partition	-	Canopy with concealed space	Poor water supply	2 shops	13 shops	4 injured \$420,000
Points-aux-Trembles, Quebec 23.3.62	183 x 61 Several shops 1 storey and basement	No	At 11.15	Overheated deep fat fryer in basement kitchen	Cartons in kitchen and fibreboard ceilings	Of basement	Concealed spaces and air-conditioning shafts	Delayed call, difficult access to basement until collapse	Most of basement	Rest of building	People escaped easily \$2,800,000
Newcastle UK 30.11.69	134 x 104 1, 2 and 6 storey department store	No	Early evening Fire Brigade called 19.31	Overheated motor inside animated display model	Xmas decorations, papier mache, polystyrene, cotton wool, draped fabrics	-	Display case with fans and decorations, unsealed party walls	Congested site for access	Whole building	Whole building	\$977,000
Mexicali Mexico 17.12.69	37 x 23 3 storey department store	No	About 18.20	Hot floodlight ignited polystyrene 'snow' in decorated showcase	Combustible wares and wood stud partitions	-	Lighting failure	Delayed call,	Lower part of building	Rest of building	Inward opening doors, no light, persons rescued by ladder 7 killed, 20 injured 75-80 at risk \$1,000,000
Salisbury UK 21.2.70	50 to 60 shops 1 storey	In some shops	At night	Arson, in toy shop	Plastics and packaging	Yes		Difficult access	Concrete roof	Rest of building	Loss not stated
Newcastle UK 1971	27 x 21 4 storeys	No	Morning	Unknown, in storage area	Foamed rubber and plastics expanded polystyrene handbags etc	Yes, 5 min after fire discovery	High density storage of wares	Congested site for access, dense smoke	2 storeys of rear of building	Most of building	Surprisingly no escape problems. Loss not stated

7. REFERENCES

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- 10) Home Office Fire Dept. Unpublished information.
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- 12) Fire, August 1971, p 128.
- 13) SILCOCK A, Unpublished information.
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- 15) NFPA Fire Journal May 1966 pp 26-27.
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- 17) Fire Prevention Guide No.1 Fire Precautions in town centre redevelopment
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