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Lessons learned

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After the event

- Should we have known better?
  - What sources of information were already available?
  - Were available sources of information such as codes, regulations and standards clear and unambiguous?
  - Were previous 'near misses' properly investigated and information shared?
- Are incidents investigated properly to ensure that lessons can be learned?

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Some historical examples

12th century

- The first recorded attempt to legislate for fire safety. The Mayor of London laid down that houses in the city were to be built of stone, thatched roofs were not permitted, and party walls were to be of minimum height and thickness.
- Not properly policed – The great Fire of London

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Great fire of London - 1666

- Started during the early hours of 2 September after a long hot summer.
- London acquired it first complete code of building regulations and means for its implementation (London Building Act 1667).
  - The walls of all new buildings were to be of brick or stone.
  - The main streets were to be widened to prevent fire spread.
  - Existing narrow alleyways were to be considerably reduced.
  - A survey of every ruin and ownership shown of every plot.

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18th & 19th Centuries

- Numerous fires in Edinburgh.
- October 1824, 'Edinburgh Fire Engine Establishment'
- Highly trained part time fire fighters with building trade experience.

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18th & 19th Centuries

- The Fires Prevention (Metropolis) Act 1774.
- Seven classes of building, with the required thicknesses of the external and party walls stipulated for each of the classes.
- Maximum floor area for stores and warehouses.
- Also dealt with human life and escape - London Boroughs to appoint surveyors and "every parish should provide three or more proper ladders of one, two and three storeys high, for assisting persons in houses on fire to escape therefrom".

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Tooley Street warehouse fire, 1861

- Jute warehouse destroyed.
- Fire spread to Hay's and other wharves and warehouses to Tooley Street shops, dwellings and offices and to an American steamer, four sailing boats and many barges.
- Fire commander Braidwood and others lost their lives as rivers of burning tallow spread the fire.
- Property damage amounting to £2 million

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Developments after Tooley Street fire

- Recognition that 216,000 cubic foot building was the largest volume that could be protected with reasonable hope of success.
- The Metropolitan Fire Brigade Act 1865 (merged the London Fire Engine Establishment and the Royal Society for the Protection of Life from Fire into one body).
- Formalisation of a professional fire brigade with proper resources largely funded by Insurers.
- Establishment of London Salvage Corps.

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Developments after Tooley Street fire

- Select Committee told that the London Building Acts were 'faulty and inadequate'.
- New similar legislation was proposed for all towns in the UK, but no action taken for many years.
- End of 19th century saw introduction of legislation covering factories and theatres concerned mainly with means of escape.

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20th Century

- 1902 a Multi-fatal fire in Queen Victoria St, City of London.
- LCC given powers under London Building Acts (Amendment) Act 1905:
  - required modifications to existing buildings to facilitate means of escape.
  - Required plans to be deposited for new buildings.
  - Published schedule of fire resisting materials.
- London Building Act 1930 – outcome of a Royal Commission.

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20th Century

- Various fatal fires in department stores and clubs prompted revisions to the Offices Shops and Railway Premises Act, the Licensing Act and the Factories Act 1961 in respect of alarm systems and means of escape provisions.
- Multiple-fatality fire in the Rose & Crown hotel in 1961, and earlier in other hotels led to the Fire Precautions Act 1971.

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Flixborough Explosion 1 June1974

Worst mainland chemical process industry disaster in the UK

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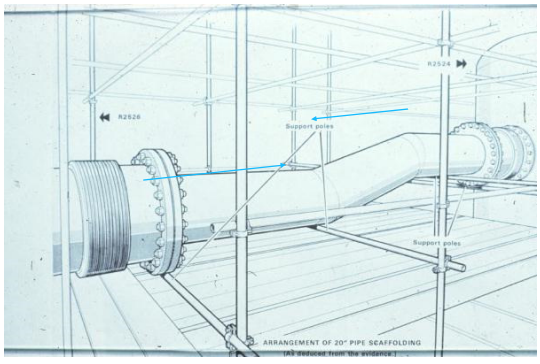

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Lessons learned

Contributed to significant changes in the understanding, management and regulation of major hazards processes.

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Flixborough - lessons learned

Management of change

- Any modifications should be designed, constructed, tested and maintained to the same standards as the original plant.
- All pressure systems containing hazardous materials should be subject to inspection and test by a competent person after any significant modification and before the system is brought back into use.
- Correct materials must be used to ensure no unforeseen effects on any part of the system.
- Any changes are subject to a HAZOP

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Design of occupied buildings

- Most of the fatalities were in the plant control room.
- CIA developed guidance on design and location of occupied buildings, with particular reference to withstanding the effects of overpressure, thermal radiation and toxic gases.

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Management competence and safety culture

- Appropriate qualifications and experience in the sphere of activity.
- Safety versus expediency

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Woolworths Manchester 8 May 1979

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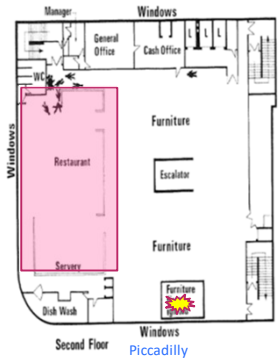

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Woolworths Manchester

- Fire started on 2nd floor comprising open plan furniture store and cafeteria fitted with half height glass partitions.
- Fire originated close to the Piccadilly wall among a stack of stored polyurethane foam upholstered furniture screened from public view by a line of bedroom wardrobes.
- Once all the materials in the storage area were burning the rate of smoke production was such that the whole of the second floor would have been smoke logged to a depth of 2m below the ceiling.
- Ten people lost their lives, most close to an escape route from the cafeteria.

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Lessons learned

- Woolworths store fire was the last in a series of fires over two decades where lives were lost in public places.
- Current fire legislation was insufficient. Absence of staff training, risk assessments, emergency planning and sprinkler systems were highlighted.
- Full scale tests in 1979:
  - Ignition and combustion of foamed plastic upholstered furniture was a key factor.
  - Sprinklers could have made escape less arduous.
- Years of campaigning led to enactment of the Furniture and Furnishing (Fire Safety) Regulations 1988.

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Kings Cross fire

- 19:30 on 18 November 1987
- Claimed the lives of 31 people and injured many more.

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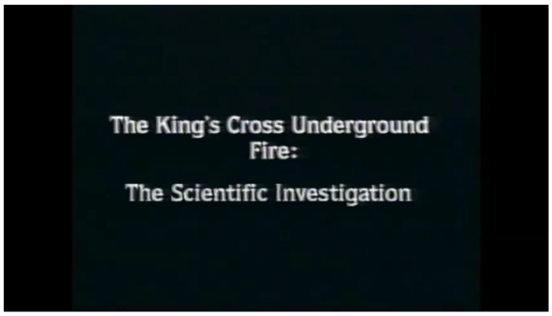

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Video by courtesy of the HSE

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Fire spread behaviour already known

- Enhancement of upward flame spread across thick fuels is observed when the inclination of the surface is increased above 15-20°
- Markstein, G.H., and Ris, J. (1972). 'Upward fire spread over textiles', *14th Symposium (International) on combustion,* pp. 1085-1097. The Combustion Institute, Pittsburgh.

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Lessons learned

- Had major impact in changing attitudes to fire safety in transport systems world wide.

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Mont Blanc tunnel fire

- 11:00 on 24 March 1999.
- Spread from the vehicle of origin two emergency vehicles, 23 trucks, 10 passenger vehicles and 1 motorcycle
- Claimed the lives of 39 people
- Caused extensive damage to the tunnel.

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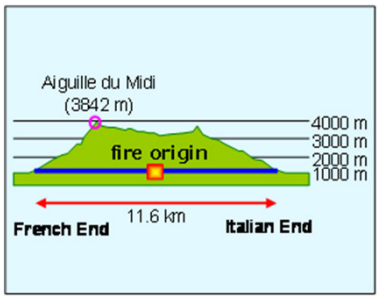

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Lessons learned

- Long tunnels require:
  - special consideration to rapid deployment of emergency fire fighting.
  - Sufficient fixed first aid fire fighting equipment available to the public.
  - Dedicated positive pressure ventilated escape routes.
  - Coordinated tunnel ventilation systems.
  - Better early detection systems

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Buncefield explosion 2005

Appointed by insurers of all commercial property outside the depot

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The explosions and fires

- 06:01 on 11 December 2005 the first of a series of explosions occurred at the Buncefield oil storage depot.
- The explosion was followed by a major oil fire that took several days to extinguish.
- A ground shock estimated to be 2.5 on the Richter scale was recorded.
- Damage to property outside the depot and business interruption cost in the region of £750m

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The unleaded petrol transfer

- Pumping started at 18:45 on 10 December.
- Shift changeover at 19:00. Mr Nash, night shift pipeline manager had prepared the planned receipt the previous day.

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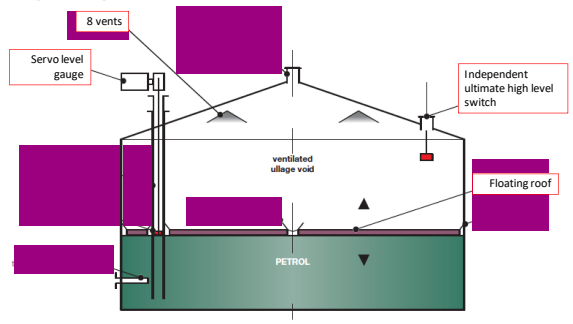

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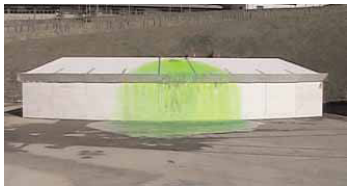

Full scale simulation of petrol flow pattern

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Shredded trees in Buncefield Lane

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View looking west showing Fuji building –Buncefield Lane and tank depot behind

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View looking east across the Fuji car park

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Lessons learned

- A very detailed COMAH report did not predict overpressure damage on the neighbouring industrial estate resulting from the ignition of a major petrol spillage.
- Research on previous similar incidents world wide-important in context of foreseeability.
- Scientific publications already in existence confirmed turbulence inducing structures will accelerate flame propagation and potentially lead to high overpressures.
- Modelling confirmed turbulence induced by the avenues of trees bounding the terminal could explain the unusually high overpressures.