

SCOSS ALERT

February 2018

Fire in Multi-Storey Car Parks

WHO SHOULD READ THIS ALERT?

This Alert is aimed at those who own, commission, design, construct, or maintain Multi-Storey Car Parks (MSCPs).

INTRODUCTION



Figure 1: Car Park and adjacent buildings. Image from Google Earth.

The severe fire at the Liverpool Echo Arena MSCP on 31st December 2017 gutted the seven-storey building and up to 1,400 cars were destroyed. Investigations are ongoing in relation to the fire and results from these will be published in due course. Fires in car parks are not uncommon; however, the Liverpool fire was unprecedented in scale because, unusually, the initial fire in one car rapidly spread to other cars. This Alert is to draw attention to the fact that similar events could occur again, and all those in the car parking business must be aware of the risks. The building had a substantial reinforced concrete frame which withstood the fire although there were collapses of some of the concrete floor slabs. In other circumstances, the consequences could be far worse, and, in the light of the need to protect life and property from fire, all possibilities of major fires in buildings must be maintained at an acceptable level. This includes considering the potential effects on neighbouring buildings.

KEY CONSIDERATIONS FROM THE LIVERPOOL FIRE

The fire

The car park is shown in Figure 1 and is about 25m away from the Liverpool Echo Arena. Much closer to the car park (separated by approximately 5m) are two apartment blocks, at the top and the right of the image, and to the left is a hotel. All were occupied. The audience were assembling for the final evening performance of The Liverpool Horse Show and the car park was almost full when fire broke out in a vehicle on the third floor. This was observed and photographed by a member of the public.

Merseyside Fire and Rescue Services arrived within a few minutes by which time the fire had spread to several adjacent cars. Some cars were abandoned on the ramps and the occupants left through the protected staircase towers. Firefighters attacked the blaze from within the third floor but were unable to stop its spread both horizontally and vertically. Figure 2 shows cars burning simultaneously on two levels. As well as extinguishing the fire, firefighters' attention turned to the critical task of saving the adjacent buildings. Merseyside Fire and Rescue Services had 12 appliances (pumps), 3 combined platform ladders (CPLs) and 3 high volume pumps (HVPs) in attendance. The fire was prevented from spreading to adjacent buildings and was put out after several hours. There were no casualties, and no complete collapse so the event is classed as a near-miss in both life-safety and structural terms.



Figure 2: Fire on separate levels. Image courtesy of Liverpool Fire and Rescue Services (MFRS).

The building

The car park was built in 2006 as part of the development of the Liverpool Echo Arena on land adjacent to the River Mersey. Overall size is approximately 70m x 60m with columns at about 7m centres in the shorter direction. There are four spans of beams in the longer direction and there are four concrete stair and service cores with fire doors onto the parking floors. As can be seen from the photograph in Figure 3, the columns and beams are substantial. Between the beams and spanning about 7m are precast ribbed floors and these have totally disintegrated down the middle of some floors and partially collapsed in other places as shown in Figure 4.



Figure 3: The scale of devastation. Image courtesy of MFRS.



Figure 4: Disintegration of floor slab. Image courtesy of MFRS.

After the fire, the stair cores were relatively undamaged, aside from some structural cracking; presumably due to differential thermal movements during and after the fire, as were the fire doors which performed very well.

The floors, however, were too dangerous to enter. A photographic survey using a specialised drone was therefore carried out. It was flown along the floors from the stair core lobbies and much information was obtained. The material will be incorporated in the forensic investigation reports.

As an open car park, this would only have needed a fire rating of 15 minutes in accordance with *Approved Document (AD) Part B*^[1]. Given that it withstood a hydro-carbon type fire for several hours with limited damage is a testament to the inherent robustness and fire-resistant nature of the structure. However, whilst focus in the AD is on the individual building and occupant safety (in this case a car park), a key factor is the need to have regard to the safety of adjacent buildings (in this case nearby buildings of high occupancy) when threatened by a major neighbouring fire.

RESEARCH ON CAR PARK FIRES

In 2006 the UK Government's Communities and Local Government Sustainable Buildings Division commissioned the Building Research Establishment (BRE) to carry out a three-year project to examine fire spread in car parks. Their report, *Fire spread in car parks*^[2] was published in 2010 and the following are extracts from this report.

Although there have been few deaths or injuries recorded to date in the UK, there are concerns regarding new and emerging risks from modern cars and alternative fuels. There was therefore a need to gather up-to-date information on fires involving cars in car parks in order that the current fire safety guidance could be reviewed and, if necessary, updated.

All of the cars used in the tests in this research programme were selected solely on the basis of age, size and availability. All were to be either less than five years old, or, if older, be of a current model [Note: The cars were therefore 2001-2006 models which were very different from current vehicles in terms of their behaviour in fires].

There are very limited regulations of fire safety in cars. The main Regulation is the Motor Vehicles (Approval) Regulations 2001 which requires fuel and electrical systems to be designed to minimise the risk of fire. Plastic fuel tanks must conform to ECE Regulation 34 which includes a fire test. It is estimated that 85% of new cars in Europe have plastic tanks.

Over time there has been an evident increase in the quantities of plastics used in cars. This may be affected by the moves towards more recyclable components.

Concerns were expressed regarding the toxicity of materials used in road vehicles, electric or hybrid vehicles, and the variety of new types of batteries, which potentially create new hazards for firefighters.

It has generally been the case that car fires in car parks are only rarely expected to spread beyond the first vehicle and many car park designs based on fire engineering principles assume only a single vehicle burning.

Clearly the study findings will be subject to review because in Liverpool there were multiple cars on fire at the same time on several levels. This fire was indeed a rare event, but it could happen again. Attention must be paid to the risks of severe fire in existing and in new MSCPs; including underground car parks.

EXISTING MSCPs

There are around 4,000 MSCPs in the UK and some of these were constructed in the 1960s and 1970s. Standards of construction were different with less emphasis on robustness and they have been subject to ageing and deterioration. Some, perhaps most, will have been modified with the installation of new equipment or lighting and retro-fitted in various ways.

Vehicles were very different at the time these older structures were designed and built. They are now substantially larger, and their fire load is much greater with bigger fuel tanks, usually now made from plastic, and a high proportion of combustible plastic materials in the bodies and the interiors.

Specific guidance on the steps that might be taken will come from consideration of the official investigation reports from Liverpool. It is however very relevant that this event has occurred during the post-Grenfell work on regulations and standards. All those in construction are acutely aware of the dangers of major fires. Rather than wait for formal guidance there are some steps to be considered in the management of existing MSCPs. Firstly, check that the relevant parts of *The Regulatory Reform (Fire Safety) Order 2005* ^[3] been complied with in England and Wales, and equivalent Regulations complied with in other regions. Then, ask whether the following been considered:

- Is there a Fire Safety Management Plan?
- How does a visitor raise an alarm?
- Is there a responsible person in charge of fire and life safety?
- Has the advice of the Fire and Rescue service been taken? If in doubt, ask them.
- Are there fire detection and fire alarm (possibly manual) systems?
- Are the fire doors and means of escape in good order?
- Has the structure been compromised by previous remedial works to leave gaps, either vertically or horizontally, in walls or floors through which smoke or flames might pass and are all gaps fire-stopped?
- Are there plastic service runs between floors, which if they melted could allow smoke and flames through the floors?
- Is the structure maintained in accordance with the recommendations from the *British Parking Association* ^[4] and the ICE publication *Recommendations for the Inspection, Maintenance and Management of Car Park Structures* ^[5]?
- Are there adjacent buildings or is the car park integral within a bigger building, where the spread of fire from the car park could result in major risk to life-safety or structural integrity of nearby buildings?
- If it is a basement car park additional considerations may apply.

This is not a complete list, merely a reminder of some of the common-sense actions that can be taken. Advice can be obtained from professional fire specialists.

NEW MSCPs

Many of the inherent problems with older car parks have been addressed since The Institution of Structural Engineers published *Design recommendations for multi-storey and underground car parks* ^[6] in 2002 (updated 2011). However, that is some years ago and there have been changes since then in materials, methods of construction and, of course in the physical growth of cars and their fire loads. No doubt the Institution and others will be re-visiting this advice in due course. Meantime, some lessons from the Liverpool fire should be considered by designers and their clients:

- Is the fire rating for car parks given in Part B of the Approved Documents sufficient given the nature of the car park in question? Remember that Approved Documents are only the minimum standards.
- Approved Document B requires only 15 minutes fire resistance for open sided car parks and provides no explicit guarantee against structural damage, loss of business continuity, and other consequential losses.
- Is the car park part of a larger development such as a shopping mall, an hotel, or a stadium where large numbers of people can congregate? If so, the effect of a fire, with and without possible collapse, must be considered in a wider sense.
- Is the design sufficiently robust to withstand an extreme event such as a major fire without collapse?
- Are there penetrations in the floors that might be vulnerable to allowing the vertical spread of fire?
- Are there areas where pools of burning fuel could form?
- Are there any flammable materials on or adjacent to the building?
- If there is a fire, how would this be prevented from attacking neighbouring buildings? Given the flow rates of water required to extinguish a well-developed fire involving multiple vehicles, as in Liverpool, are the diameters of the water mains on which hydrants are located adequate and are there alternative water supplies available (i.e. open water)?

Again, this is not a comprehensive list and is simply a reminder of the need for *Reflective Thinking* ^[7] when weighing up risks and the need to learn lessons from recent events including the Grenfell Tower fire and the Liverpool fire. As before, advice can be obtained from professional fire specialists.

SPRINKLERS

The adoption of sprinklers in buildings for which they are not prescribed is a subject of considerable debate. As far back as 1987, Australian researchers *Thomas and Bennett* ^[8] reported the findings of nine tests, involving twenty cars, looking at fire development in closed car parks. The results were:

- A sprinkler system was effective at controlling a developing fire.
- A sprinkler system was equally as effective at controlling a fully developed fire.
- Without sprinklers, fire is likely to spread from car to car.
- With sprinklers, spread of fire is unlikely.

Evidence derived from global research and research conducted by the BRE in their 2010 report *Fire spread in car parks* ^[2] considered the effectiveness of sprinklers controlling fires in car parks and said; *'the incidence of fatalities and injuries is zero and the property loss is around 95% lower than that of an uncontrolled fire'*.

Coming right up to date, the National Fire Chiefs Council's (NFCC) position in relation to car parks in 2018 is as follows:

- The NFCC recommend that consideration is given to installing sprinklers in open sided car parks to protect property, including the fabric of the building. While there have been few incidences of fatalities in car parks, there have been recorded fatalities to firefighters due to structural collapse abroad.
- The NFCC strongly recommends that enclosed car parks should be fitted with sprinklers, as is common in Europe and also recommended by NFPA (National Fire Protection Association) 88 in the USA.
- The NFCC strongly recommends that basement car parks, and in particular those with associated accommodation above, are fitted with sprinklers. This is a common requirement in Europe and recommended by NFPA 88 in the USA. Research undertaken by the *BRE in 2010* ^[2] also support this approach.
- The NFCC strongly recommends that automated car parks are protected by sprinkler systems due to the extra density of fire loading created by stacking cars in carousel or racking systems. Increasingly this is being recommended globally and is also required by NFPA 88.

In February 2018 a vehicle caught fire on the 7th floor garage of the 100 storey John Hancock Center in Chicago. The Fire Department extinguished the fire, and officials said the sprinklers in the building contained the fire until crews arrived. Perhaps a significant example of the benefits of sprinklers.

Clearly, cost-benefit analyses may need to be performed when sprinklers are considered for installation in car park structures, both in retrofit and new-build scenarios. These analyses should consider the particular fire hazards and client dictated performance objectives – potentially over and above strict compliance with the Approved Documents.

SUMMARY

Fires in MSCPs do occur and are usually extinguished rapidly. However, the Liverpool fire provides compelling evidence that this is not always the case, and steps should be taken by fire engineers and structural engineers, as well as by owners and managers of similar facilities, to consider the potential impacts of fires in car park structures on both life and property. The Liverpool fire was comparatively benign in that there were no casualties. On another occasion the consequences could be quite different, and given recent disastrous fires, would likely be unacceptable to society.

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