

Standing tall

*The construction of tall and even super-tall buildings, particularly in the Gulf and Far East regions, raises new fire safety concerns for those responsible, from project managers to insurers. **Stewart Kidd** reports*

FIRES ON construction sites have, for many years, been recognised as a serious problem for construction companies and insurers, but less of a public safety issue since there are relatively few fire deaths in such incidents.

However, the trend for ever-taller buildings, particularly in the Gulf and Far East, has resulted in a number of significant fires during construction which have caused deaths and demonstrated the difficulties facing fire brigades when tackling such incidents. On several occasions, helicopters have had to be used for fire suppression and rescue. Insurers have long had concerns about the potential for loss on tall building projects, and these fires have demonstrated that their concerns are well founded.

Taller developments

In the past, the insurers' view was affected by the fact that construction projects tended to be insured under construction/contractors' all-risk (CAR) policies, handled through specialist brokers and insurers rather than by the 'traditional' fire insurance market. Many projects were covered by block policies (with high excess levels) purchased on an annual basis by the larger construction firms, and fire claims tended to be small.

The construction boom in larger, taller developments, particularly in the City of London in the 1980s, upset this market when a number of significant fires changed the insurers' views of construction fire safety. Two of these fires, at Minster Court and the Broadgate development, resulted in claims exceeding £120m – reportedly at a time when the global income for CAR insurers was less than £110m. These fires provoked a major change in attitude.

Now, the drive for tall and even super-tall buildings reaching over 450m in height – particularly in many Middle and Far Eastern cities – is bringing new challenges. Indeed, there are issues arising out of modern tall developments that previously do not seem to have concerned those responsible, including the municipalities and fire/civil defence authorities, owners, project managers, construction companies and local insurers.

It has long been accepted that it is impossible to fight a fire externally in a building more than 35m tall – effectively the maximum height of a fire brigade ladder or hydraulic platform. As a result, most high-rises (that is, buildings more than 50m tall) have relied on internal firefighting measures, such as automatic sprinkler systems, fire compartmentation, ventilation systems, fire risers and hydrants, firefighting shafts and staircases, and fire service lifts. However, such measures are normally only available in completed buildings.

With more and more tall buildings under construction or being planned, there are real concerns over fire safety management in these projects. Estimates suggest that more than 200 buildings over 100m tall are under development, and will be completed sooner or later, despite delays stemming from the worldwide financial problems of 2008/09. Many of these projects involve buildings over 450m tall, including:

- Al Burj/Nahkeel Tower, Dubai, 1,400m
- Murjan Tower, Bahrain, 1,022m
- Shanghai Centre, 632m
- Incheon Towers 1 and 2, South Korea, both 614m

- Tower of Russia, Moscow, 612m
- Chicago Spire, 610m
- Freedom Tower (One World Trade Centre), New York City, 541m
- International Commerce Centre, Hong Kong, 484m

As the vast majority of these projects are taking place outside of Western Europe and the USA, there could be potential issues with the resources available for building code enforcement, fire brigade resourcing and local safety regulation enforcement in some of the countries – inevitably leading to insurers having at worst to adopt a quasi-regulatory approach or, at best, to provide significant safety management input.

Hazard and risk assessment

One issue that has taken some time to be fully appreciated by the construction industry is how vulnerable high-rise construction projects can be. Indeed, it is the ever-changing nature of construction projects that presents the greatest risk.

It is true that in the early days of any building project there is little risk of fire. Wet processes, foundations and concrete pouring are all relatively low-risk activities. However, even at this stage, fires can occur. Timber shuttering burns extremely well; membranes used in damp proofing (and their adhesives) are combustible; and materials are delivered to site in disposable packaging that is also combustible. In addition, modern methods of construction, such as slip and jump forming, use timber formwork and large volumes of often flammable hydraulic liquid.

From an insurance perspective also, construction projects present a unique challenge because of the difficulties of risk, taking into account the changing nature of the site activity and the ever-increasing financial exposure that increases as a project approaches completion. Table 1 demonstrates the sort of risk levels that might exist in a typical tall building on a 36-month construction programme.

Table 1: Risk levels during tall building construction

Months	Site activity	Fire risk level	Sum insured
0 - 6	Site formation, foundations, piling	Low	20% of total project
6 - 24	Tower construction/slip forming	Moderate	50% of total project
24 -28	Cladding and services	Moderate – High	65% of total project
28 - 36	Internal fit out	High	100% of total project

Clearly, any fire taking place after, say, month 24 is more likely to result in a major loss than a fire before then. Fires that happen after the installation of cladding begins will present a much greater probability of serious damage, because smoke and heat will be contained within the structure rather than being quickly vented.

Other factors that need to be borne in mind relate to insurance other than CAR for the consequences of a fire – as opposed to fire damage itself. A major retail mall might purchase insurance for ‘advance loss of profits’ that would pay out pre-agreed sums to compensate the owners for loss of rent if the mall were not able to open on time due to

an insurable loss. So even a small fire could trigger a large insurance claim, were it to delay the project for more than a few days (as would almost certainly be the case).

Fire safety problems

The causes of fires during tall building construction do not differ radically from those on 'conventional' construction sites. What is different is the scale and extent of the problems, and complications regarding egress for the workforce, fire brigade access, water supplies and firefighting.

Causes can involve electrical risks, hot work, smoking, rubbish burning, overheating equipment and escapes of gases or flammable liquids – all of which are well recognised and should be amenable to normal fire safety measures. However, specific risk areas in tall buildings include:

- slip and jump forming equipment, and other systems with large hydraulic fluid requirements
- storage of building materials within the structure
- temporary buildings within the structure
- diesel- and petrol-powered generators, compressors, welding machines and tools
- part-occupation, particularly of basements, for car parking, storage, workshops and offices
- discarded shuttering and timber

In some cases, the necessary expertise of local authorities in supervising the design and construction of tall buildings may be problematic. It is also possible that local codes may be silent on the very special problems associated with tall buildings.

Risk management

When it comes to general fire precautions during construction work in tall buildings, there are a number of issues to be considered, including:

Storage of materials

While off-site storage space and transport can be expensive, this is always to be preferred to on-site storage. Although much of the material used for construction may not be easily combustible, the packaging that protects it usually is. In addition to cardboard and plastic sheet, the contribution to the fuel load of palettes and cable drums should not be overlooked. On one site, it was calculated that there was enough timber in a storage area for cables to generate a 7MW fire. In another location, 200 electrical control cubicles were protected from transit damage by timber frames, thick plastic sheet and plastic tarpaulins. Not only would this packaging have provide fuel for a 3-4MW fire, but the plastic materials would have generated huge volumes of acidic and toxic smoke.

Exit routes and emergency drills

The ever-changing patterns of construction work can mean that a main escape route via a staircase on Monday will not be available on Wednesday, so high-quality signage is essential. Where mixed nationality work groups are employed, attention should be paid to possible confusion due to language problems. Where there is a major change in access or egress, this should be communicated to contractors and their operatives formally (during daily or weekly meetings), by posters, and informally (during 'toolbox' talks or lunchtime safety briefings).

Fire drills should be properly managed, timed and supervised and, if possible, filmed. The local fire brigade and insurers should be invited to observe, and a formal debriefing held the same day. Emergency procedures for the evacuation of casualties using cages should be practised as often as fire evacuation drills.

Removal of rubbish

Failure to remove rubbish is one of the most commonly encountered hazards. Perhaps the only reasonable excuse for non-compliance is in very tall buildings, where hoist access may be restricted. One solution is to permit the limited accumulation of waste in certain specified areas on specified floors, and for a contractor to be tasked to remove the waste when hoists are less in demand, usually at night.

On most sites there can be no excuse for waste accumulations when all that is needed is the presence of skips. If these fill up quickly, then either more skips are required or the skips need to be cleared more frequently.

No-smoking policy

Smoking should be banned in all construction areas and, only where permitted by law, restricted to designated areas.

Hot work controls

Formal compliance with a hot work permit system is the foundation of good construction fire safety management. Permits (using multiple languages, if necessary) should be issued and cancelled on a daily basis to named individuals only for specified operations, and all hot work should be undertaken in the presence of a suitably equipped and trained firewatch. Adequate resources should be provided to allow for spot checks on permit holders during the working day by safety officers or inspectors.

Flammable gases

Consideration should be given to restricting or even banning the use of oxyacetylene in favour of other equipment, such as oxypropane. If oxyacetylene is essential, it should be possible to set up a procedure to ensure that acetylene is brought to site for that work only and removed at the end of every working day.

Fitting out

Probably the most dangerous part of a construction project takes place when cladding is complete and fitting out begins, but before fire compartmentation or fire detection and suppression systems are operational. During this period, it is the practice of trying to prevent damage to finished areas that can generate high levels of hazard.

Where *ad hoc* materials like plywood, plastic sheeting and tarpaulins are used for these purposes, this increases the fuel load in the building and also creates the possibility of large volumes of toxic and acidic, smoke generation. This can be prevented by ensuring that fit-out contracts contain requirements for all protective cladding (including scaffolding sheeting) to be either non-combustible or to comply with the Loss Prevention Certification Board standards, LPS 1207: *Fire requirements for protective covering materials* or LPS 1215: *Flammability requirements and tests for LPCB approval of scaffolding materials*.

Management systems

One of the issues with tall buildings can be the complexity inherent in the contractual process of actually undertaking the construction. Some success has been achieved in viewing the safety management process as a facet of the construction management

process. It is no coincidence that the best-run fire safety programmes are those where a professional project management company runs the site.

In the case of the Burj Dubai tower and urban development, the project managers appointed their own safety manager and required the joint venture companies' safety managers to work within a management structure set-up. Other companies involved in the project as nominated contractors or subcontractors also supplied safety personnel to work in a collaborative framework. The effect of this approach was that the project safety manager did not just have three or four safety inspectors working for him, but more than 30 – each assuming responsibilities for his own company's work area and operatives, and also taking wider responsibility to deal with safety problems anywhere on the project. Daily meetings of the safety group led to greatly improved communications and an enviable safety record for this project.

The risks and consequences of fire present the greatest danger to a high-rise building, and such buildings are most at danger during construction, especially fitting out. Insurers and fire brigades play an important role in supporting fire prevention, but ultimately it is the responsibility of the businesses and contractors involved to ensure that appropriate measures are taken □

Stewart Kidd is a loss prevention consultant with wide experience of managing construction site fire risks

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Joint construction code

THE 7th edition of the joint code of practice, *Fire Prevention on Construction Sites*, features new guidance on managing the risks on high-rise building sites.

Published by the Fire Protection Association (FPA) and the Construction Federation, the code sets out general precautions and safe working practices for the design and planning stages of construction projects (see *Fire Risk Management*, June 2009, p.XX).

The latest edition – now available from the FPA – also features for the first time special guidance on tall buildings. The section on high-rise construction explains that normal fire protection measures may not be applicable on such sites – for example, due to excessive evacuation times from upper levels, or incomplete compartmentation. It recommends that a specific fire risk assessment be undertaken to develop appropriate provisions, in consultation with the fire service and before work commences at a height at which mechanical rescue by firefighters is no longer viable □