



Mitsui Sumitomo Insurance Group

Risk Guidance Note 37

Fire Safety of Timber Frame Buildings

Advice on the Suitability, Construction and Occupation of Timber Framed Buildings



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1. Scope

The advice contained in this document relates primarily to large timber framed buildings i.e. those of four storeys or more and/or those designed for multiple occupation. It is applicable to the construction of buildings such as hotels, flats, houses of multiple occupation and offices. However many of the recommendations are also appropriate to single dwellings. The purpose of this document is threefold:

1. To help a design team decide whether a timber frame is the appropriate form of construction for a particular project in a particular area by detailing what factors should be considered in an initial risk assessment.
2. If the design team decide that timber frame is the appropriate method of construction to then provide guidance on the control of the fire risk during the construction phase*
3. Finally, to lay out general principles to be adopted through both the construction phase and the occupancy phase to help ensure that the finished building is fit for purpose (in terms of fire safety).

* The advice contained in this document is over and above the guidelines laid down in the ***Joint Code of Practice on the Protection from Fire of Construction Sites and Buildings Undergoing Renovation***

2. What is a Timber Framed Building?

A timber framed building is one where all structural, load-bearing parts comprise timber elements i.e. the load bearing walls, floors and roof are all timber. Quite often the timber frame will be faced with a non-structural outer cladding of brickwork (or other material) which gives the outward appearance of a more solid structure: herein lies one of the problems. It is very difficult to identify a timber framed building once it has been completed.



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In most forms of timber framed construction the walls (internal and external) comprise timber studs; to the outside of the external walls a plywood skin is applied (to provide lateral support) and on the outside of this a weathering layer; which could consist of a wide range of materials including timber boarding, brick, concrete block or metal cladding.

Timber framed construction comes in many forms but the term essentially refers to a structure whose supporting members wholly comprise timber.

2. The Problem with Timber Frames

It is widely accepted that fires in timber frame buildings are more extensive than fires in buildings constructed of traditional materials, such as brick or concrete. Fires during the construction phase can be particularly devastating as the timber is often unprotected and there is little to prevent the involvement of the whole building.

In traditional projects, little if any of the fire load present relates to the building structure until later in the project when roofing, services, finishes and furnishings are installed. Much of the fire load that is present relates to sundry items, packaging and sheeting, for which principles of fire risk mitigation are well understood and established in the construction industry.

A fire starting on a timber framed construction project will rapidly spread to involve the building structure itself leading to inevitable structural collapse, spread to surrounding structures and properties and a conflagration that the fire service are unable to tackle. It may not be until later in the project that the building has a degree of fire resistance, once cladding and compartmentation (mostly in the form of plasterboard and fire doors) have been put into place. For this reason, customs and practices that may be appropriate in a traditional construction environment must be avoided or modified when working with timber frame.

In the UK, timber frame (on large projects) can be considered a relatively new technology for construction firms and associated trades alike and education is a key part of fire prevention and mitigation. Inevitably, there are crucial areas where a lack of understanding can lead to increased risk of fires starting or spreading once they take hold. For example, and not surprisingly, trades using hot work must be particularly carefully controlled in a timber framed construction environment. Furthermore, a timber framed building's whole philosophy is based around containing a fire to the point (room) of origin, primarily for life safety purposes, and the effectiveness of such containment is highly dependent on diligent and professional installation standards, in particular with respect to fire-stopping of service penetrations at the appropriate layer of construction, installation of compartment barriers in roof voids and general compartmentation installations.

The risk associated with timber frame buildings does not disappear once the building is occupied. The buildings may be clad with brick and can appear externally and internally as if traditionally constructed. Occupiers or tradesmen making modifications need to understand the nature of the construction materials and any associated risks. For example, a plumber undertaking hot work on copper piping penetrating a wall cavity could ignite elements of the internal structure, such as combustible insulation (if used) or the timber frame itself. This highlights a significant potential concern with timber framed construction: fire spread in wall cavities and void spaces which is difficult to detect and even more difficult to extinguish.



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A fire, caused by brazing of an overflow pipe on the outside of this building started a fire which spread through the cavity and emerged in the roof space. The Fire Service attended on 4 consecutive days as the fire broke out in different parts of the building having spread un-noticed through the cavity. The fire was only considered to be out once the building had been demolished.

In the United States, where timber framed construction has been commonplace for many years, certain building codes require the installation of sprinklers where timber frame is used. It is not thought that such measures are planned in the UK, although the Welsh Assembly has recently introduced legislation requiring the installation of automatic suppression in all new homes and other residential buildings. The efficacy of sprinklers in timber framed building fires remains a point for debate due in part to the prevalence of wall cavity fires as mentioned above. In the UK we seem to have plunged headlong into this form of construction without heeding the experience of other countries with a significant loss history associated with this form of construction.

As we move into a future where carbon neutrality and sustainability will be key factors in the selection of building methods, we can expect timber framed construction to at least maintain its presence in the UK and, more likely, to grow.

3. Is timber framed construction suitable?

The decision on whether to use timber frame or an alternative form of construction should be subject to a detailed risk assessment early in the concept / initial design stages. Factors that should be considered in this risk assessment include:



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3.1 The views of the Health & Safety Executive and the local Fire and Rescue Service. Both bodies must be notified of the intent to build and their advice sought on the suitability of such construction.

3.2 The proximity of surrounding buildings: the potential for fire spread to neighbouring structures either via radiated heat or blown embers. The likelihood of spread between buildings will be dependent upon many factors including building height, width, types of opposing construction, wind direction etc. It may be possible to model the potential for fire spread but there is currently no accepted formula for doing so. This potential for fire spread may limit the number of urban sites where timber frame construction is considered to be a safe construction method.



3.3 The nature of the area: the majority of fires on both construction sites and in operational buildings are caused by arson. The environmental benefits of timber frame construction in a social housing scheme in a deprived city centre location are highly likely to be outweighed by the potential for a fire occurring. Certain areas are notorious for gang or drug related activity or for security contractor warfare. The advice of the local Crime Prevention Officer is critical in this aspect. Also important is the nature of the surrounding buildings e.g. listed or heritage buildings, critical infrastructure installations etc. where the third party implications may more severe.

3.4 The number of people likely to be affected by a fire during construction: any emergency planning must take into account the welfare of surrounding occupants. The ability to safely evacuate large numbers of people (age and social class considered) must be given due consideration. Under the Regulatory Reform (Fire Safety) Order the person responsible for fire safety on the construction site also *“has a duty to any person in the immediate vicinity of the premises who is at risk from a fire on the premises”*.



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3.5 The building system to be used: timber frames come in a variety of forms, with some having a degree of fire protection already applied prior to delivery to site (pre-formed panels with plasterboard and/or insulation already applied, or timbers treated with a fire retardant chemical). The degree to which the system can provide a resistance to ignition and propagation should be considered. It should be noted that the treatment of timbers is currently in conflict with BREAM (the sustainability argument).

3.6 The layout of the site: if the project comprises a number of discrete blocks then the spatial separation and the sequencing of their erection may reduce the potential for fire spread. The greater the spatial separation that can be achieved the lower the loss potential. Good separation also increases the chances of effective Fire Service intervention.

3.7 The size of the site: where the layout and size of the plot does not allow for a perimeter fence and a clear space between the fence and the building under construction then an acceptable standard of security may be very hard to achieve. Where the building under construction itself forms part of the perimeter boundary then achieving an acceptable standard of security will be all the more difficult.

3.8 The height of the building and the number of people working within: the height will affect the travel distances and also the extent of radiated fire spread to neighbours.

3.9 Internal compartmentation: whilst the incorporation of fire break walls in timber framed construction is unusual, if a degree of segregation can be introduced into the design and incorporated into the structure as it is built, the potential for loss may be decreased.

3.10 The availability and price of future insurance cover: notwithstanding the possible reluctance of Insurers to offer cover for timber framed construction projects there *may* be problems sourcing building property insurance cover for the operational life of the building (especially where the Insurer was not involved in overseeing the design, management and workmanship during the construction phase). There also appears to be the potential for Insurers to take legal action against contractors for poorly installed fire protection. In addition, the availability of interruption insurance (loss of profits) is critical in mitigating the effects of fire during construction.

3.11 The final use of the building: as the integrity of the building is reliant, in many areas, on one or two layers of plasterboard, any modifications to internal walls can have serious implications for the safety of occupants. In certain types of building e.g. private flats, the potential for uncontrolled/unmanaged alterations during the life of the building is high. The risk of such unauthorised alterations is likely to be lower in, for example, a hotel occupancy where works will probably be better managed.

3.12 The availability of water supplies and access for fire fighting activities: though it would be very hard to extinguish a well developed fire in a partly finished timber frame building, water supplies may be critical to preventing fire spread to surrounding structures.

4. Managing the construction risk

N.B. All the measures detailed below are in addition to the guidelines laid down in the *Joint Code of Practice on the Protection from Fire of Construction Sites and Buildings Undergoing Renovation (JCOP)* which must be considered as an absolute minimum standard for the protection from fire of construction sites involving timber frames.



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- 4.1** The local Fire and Rescue Service should be notified of the project prior to commencement and be requested to visit site to assist in the development of the Fire Safety Plan. Any recommendations they make should be incorporated into the fire safety plan. The Fire & Rescue Service should be invited back on site at regular intervals to review the fire safety measures in place. This will have the added benefit of raising their awareness of how the building is constructed. No construction should take place until the Fire & Rescue Service have attended site and provided their input into the Fire Safety Plan.
- 4.2** The Health and Safety Executive should be notified as soon as the decision has been made to use timber frame construction methods (regardless of their involvement at the design stage).
- 4.3** Formal notification to the Insurer is mandatory. The Insurer's representative should be allowed access to visit the site at his/her discretion.
- 4.4** The timber frame contractor should appoint a Fire Marshal, to report directly to the Principal Contractor's responsible person, to assist in the implementation of the Fire Safety Plan.
- 4.5** The Fire Risk Assessment and Emergency Plan should take into account the potential effects of fire on any neighbouring properties, and any neighbours likely to be affected should be included in the emergency response planning.
- 4.6** By way of formal inspection the Responsible Person (or his delegated representative) should ensure that no installed passive fire protections are compromised by subsequent construction activities (see also operational risk below).
- 4.7** Fall arrest systems comprising polystyrene materials should not be used. Such systems often claim to be "fire retardant" but this retardant covering will only resist a certain level of inception hazard, and the material within introduces a very high fire load into the building.
- 4.8** Waste skips and gas stores, where possible, should be sited a minimum of 20 metres from the building. Waste skips and bins for combustible materials should be lockable. If wheelie bins are used they must be securely chained to prevent movement.
- 4.9** All combustible waste to be removed from the building at the end of each working day. This should be verified by a daily documented housekeeping and safety inspection record.
- 4.10** The area between the building under construction and the perimeter fence should be kept clear of all combustible materials. Where on-site storage space is limited, a remote storage location should be considered.
- 4.11** Where hot work has been carried out, in addition to the standard hot works controls, the area must be continually monitored for 1 hour following completion of the hot works and revisited 2 hours after completion, prior to closing out the permit.
- 4.12** Security is paramount and, contrary to other published guidelines, should not be determined by the size of the building. The risk of arson is the same whatever the size of the structure: it is only the quantum of the resulting loss that differs.



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4.13 The site should be enclosed with plywood hoarding to a minimum height of 2.3 metres topped with anti-climb measures; or permanent security fencing installed (palisade or weldmesh) topped with anti-climb measures. All gates and doors should be secured with high security closed shackle/concealed padlocks and chains of a commensurate strength. Heras fencing is not generally acceptable as perimeter protection for timber frame construction sites.

4.14 A SIA (Security Industry Authority) accredited manned guarding company should be contracted to provide access control throughout the day and guarding duties at times when the site is not operational. All access points should be manned at all times and card operated turnstiles should be provided for employee access. Overnight a minimum of two guards should be present and equipped with means of immediately (via a single action device) contacting their security control. The guards should perform at least hourly patrols which should be monitored by clocking points. Where SIA approved guards are not engaged a remotely monitored, movement activated CCTV system should be installed in accordance with BS8418. The level of security should be determined by a security risk assessment but, where lower levels of protection are being considered, the advice of the Insurer should always be sought.

4.15 To reduce the site's lure to potential thieves/arsonists, all theft attractive tools and materials (not already incorporated into the building) should be securely locked in steel cargo containers. Plant should be secured in accordance with the Plant Security Code of Practice (produced by the Plant Theft Action Group (PTAG)).

4.16 Active fire protection (sprinklers) only really becomes effective once internal partitions and ceilings are complete. Systems are rarely commissioned until around PC (practical completion). Wireless automatic fire detection can provide early warning of fire but is only likely to be effective where rooms are completed (i.e. lined with plasterboard). Automatic detection should be installed on a phased basis as parts of the building are completed. The system should signal to a permanently occupied location.

4.17 Phased occupation of part finished timber framed buildings is not acceptable. Whether phased occupation of a finished block is acceptable must be determined by the distance from buildings still under construction and the inherent fire resistance of the finished buildings.

4.18 Where the development comprises discrete (detached) blocks, the completion of a block (and consequently its installed fire protection) prior to commencing the adjacent block will reduce the potential for fire spread and therefore reduces loss potential. Additionally, alternate block construction can also provide natural structural separation.

4.19 Early installation of doors, windows and partitions may reduce the amount of oxygen available to a growing fire. Whilst it is a commendable objective, effective fire separation in a part completed timber framed building is extremely difficult to achieve: at best efforts to compartment the building during construction will probably buy time for occupants to escape.

5. The operational risk

The fire protection of timber framed buildings is reliant upon the integrity of internal partitions: walls and ceilings. If any of these are poorly installed or breached then the integrity of the whole building can be compromised. The acceptability of using a timber frame in large multi-storey structures is based on a single set of tests carried out at the Cardington Research Establishment. What is not widely publicised is that following the alleged "successful" fire tests, the test fire reignited some time later within a concealed space. Control and management of workmanship



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and installation standards during the build phase are fundamental to fire safety of the finished build. The following measures are recommended:

5.1 Third party / independent certification of all fire protection measures incorporated into the building. Within timber frame structures critical elements include: internal dry linings; wall, floor and ceiling junctions; electrical fixes; plumbing; cavity barriers and fire stopping around service penetrations. Due to the nature of this type of construction (almost all elements have a role to play in the fire protection strategy) this may result in an almost permanent presence on site for part of the contract programme. The third party certification may be undertaken by the Principal Contractor if he has the appropriate competence. No reliance should be placed upon Building Control for the certification of passive fire protection measures. Installers should not be allowed to self-certify. Comprehensive documentation should be maintained as an audit trail and this information should be made available to the building owner. **The importance of a rigorous inspection regime cannot be over-emphasized.**

5.2 The positioning and correct installation of cavity barriers is critical to the future fire performance of the building. The UKTFA document (see references) should be followed for guidance on correct positioning of barriers. Fire stopping works should only be carried out by companies with the relevant experience or third party accreditation in passive fire protection works (refer MSIG Risk Guidance Note 34).

5.3 Eaves and barge boards should be constructed of fire resistant materials to stop external fires spreading to the roof space. Fires set in waste skips, bins and other combustible materials stored against the buildings are a very common cause of loss especially if a fire can enter the roof space.

5.4 Avoid unfavourable construction details such as: mounting consumer boards on party walls; combustible insulation in cavities; friction-fit cavity barriers; PVC sheaths on cavity barriers; combustible vapour barriers and roofing felts

5.5 A user manual should be provided for the building which details the type of construction, the fire strategy and the methods of fire protection / segregation installed. The user manual should make clear the nature of works that are likely to compromise the installed fire protections.

5.6 Throughout the life of the building the person responsible, be it the owner, managing agent, building manager etc. should undertake a full risk assessment of ANY subsequent works to be carried out to the completed structure. In flats and parts of buildings in private ownership this control may be very difficult to achieve. Occupiers may need to be provided with written guidelines when taking occupation.

5.7 If feasible, hot work of any nature should be prohibited throughout the life of the building, and particularly so in roof spaces. Where such work is unavoidable it should be subject to at least the same level of control laid down in the Joint Code of Practice.

5.8 A labelling system should be employed on the outside of the building to make it clear to all (maintenance operatives, the fire service etc.) the precise nature of the construction. The Fire & Rescue Service no longer have extensive training in construction methods and timber frames are notoriously difficult to identify once clad.

5.9 Sprinkler protection is strongly recommended for all occupancies in timber framed structures. Active fire protection will control the size of the fire and help restrict it to the



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compartment of origin. It may also mitigate the effects of compromised passive fire protection that may have resulted from the occupation of the building.

5.10 Horizontal evacuation strategies are not appropriate for timber framed buildings of multiple occupation: the risk of concealed fire spread is too great.

References

- Joint Code of Practice on the Protection from Fire of Construction Sites and Buildings Undergoing Renovation (7th edition 2009)
- **MSIG** RGN 34 Third Party Accreditation
- **UKTFA** Best Practice Guidance on the Installation of Cavity Barriers

Other Sources of Information

- **Communities and Local Government** BD 2846 Compartmentation in Roof Voids
- **Electrical Safety Council:** Electrical Installations and their impact on the fire performance of buildings
- **Health and Safety Executive** HSG 168 Fire Safety in Construction Work Guidelines
- **UK Timber Frame Association** (UKTFA) Fire Safety on Timber Construction Sites (16 step guide)
- Regulatory Reform (Fire Safety) Order 2005
- Construction (Design and Management) Regulations 2007
- **CIBSE** Guide E
- BS 5588-12: 2004 sections 15 & 16 managing fire safety on construction sites

For further assistance on this or any other risk management topic please contact your Account Manager at:

Risk Engineering
Mitsui Sumitomo Insurance Underwriting at Lloyd's Ltd
25 Fenchurch Avenue
London
EC3M 5AD

Telephone + 44 (0) 20 7 977 8321
Facsimile + 44 (0) 20 7 702 6380

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