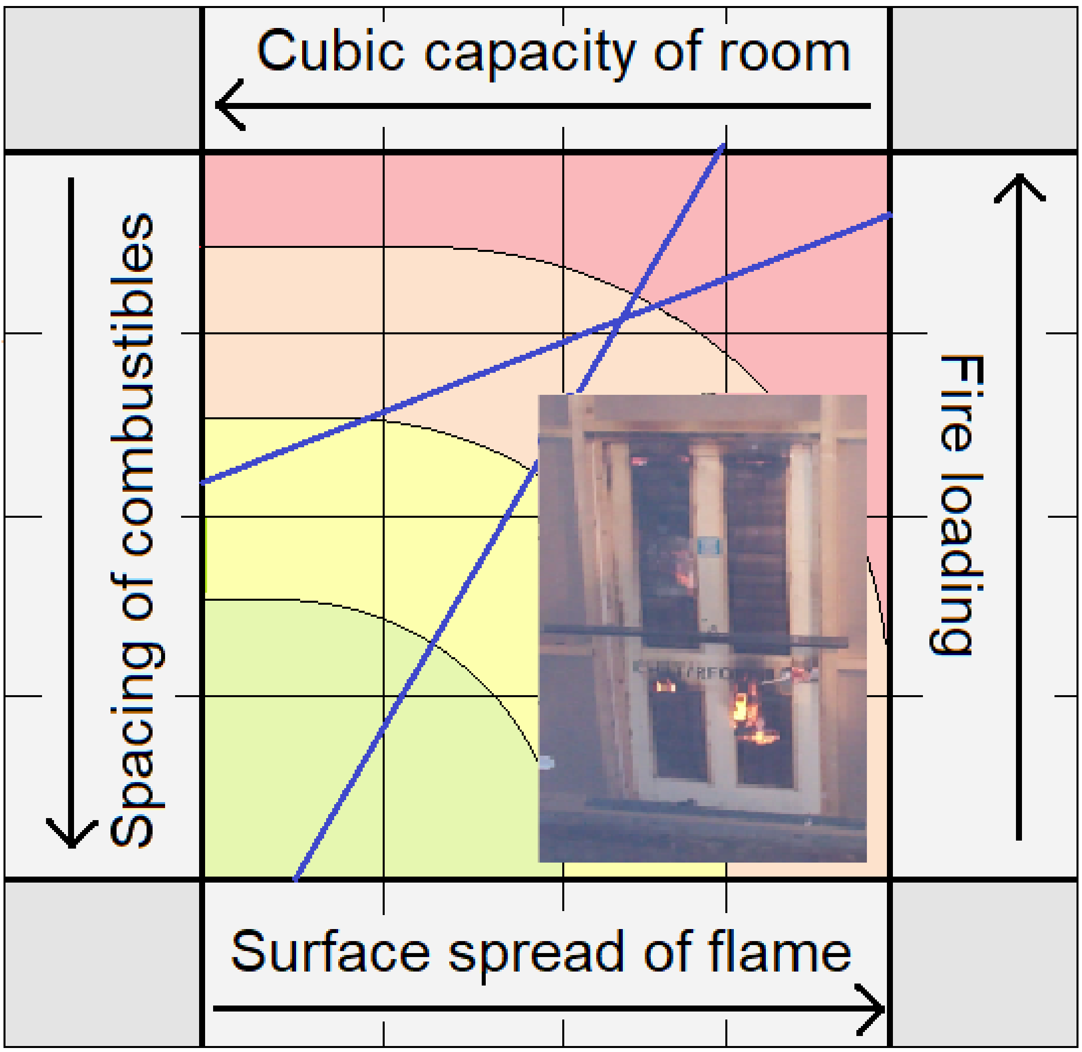
The Institution of Fire Engineers

Special Interest Group for Heritage Buildings

Guide to the fire resistance of Historic timber panel doors



Historic England

SUPPORTED BY Ecclesiastical Insuring, Investing and Protecting

Contents

Introduction

> **The safest place for a heritage door is in its original setting.**
>
> **Its removal into safe storage and replacing it with a modern replica does not guarantee its safety in the future, when the reason for its storage has been forgotten.**

Importance of fire and smoke resistant doorsets

Fire and smoke can cause injury and death, with smoke being the greater threat to life. Smoke is toxic, it asphyxiates, it causes loss of visibility and the gases it contains are flammable in certain concentrations. It can also cause serious damage to artifacts and building fabric some distance from the seat of the fire.
Doorsets may therefore need to be modified so that occupants can escape in relative safety and the property can be protected from fire and smoke.

The risks can be reduced by

- Maximising the time available to use escape routes safely

- Containing fire and smoke within the room where the fire started or within fire compartments.

Keeping Escape Routes Clear of Smoke

To avoid fires escape routes and staircase enclosures must kept free of combustibles and ignition sources.

The major threat is then from the spread of fire and smoke from adjoining rooms, which would justify testing from the risk side only
.
Doors opening onto dead end escape routes and protected staircases should therefore have a degree of fire and smoke resistance.

Compartmentation

Fire may spread rapidly if left unchecked. Sub-dividing the building into fire resisting compartments will restrict the spread of fire and

- Limit the damage to the building and contents, particularly collections, by containing the fire and smoke within a single fire compartment.

- Limit the size of fire tackled by the fire service and allow them to fight the fire internally or “offensively”.

- Reduce the risk of fire, that one group of occupants might cause, spreading to affect another group in a multi-occupied building.

- Limit the amount of oxygen available to the fire, which helps reduce its temperature and the damage to the structure.

When considering measures to upgrade the existing levels of compartmentation the architectural, conservation and curatorial implications must be assessed, to determine the most sympathetic way of progressing.

Chapter 1 Purpose and scope of document.

Deciding on how to approach each door and the design of historic doors and frames.

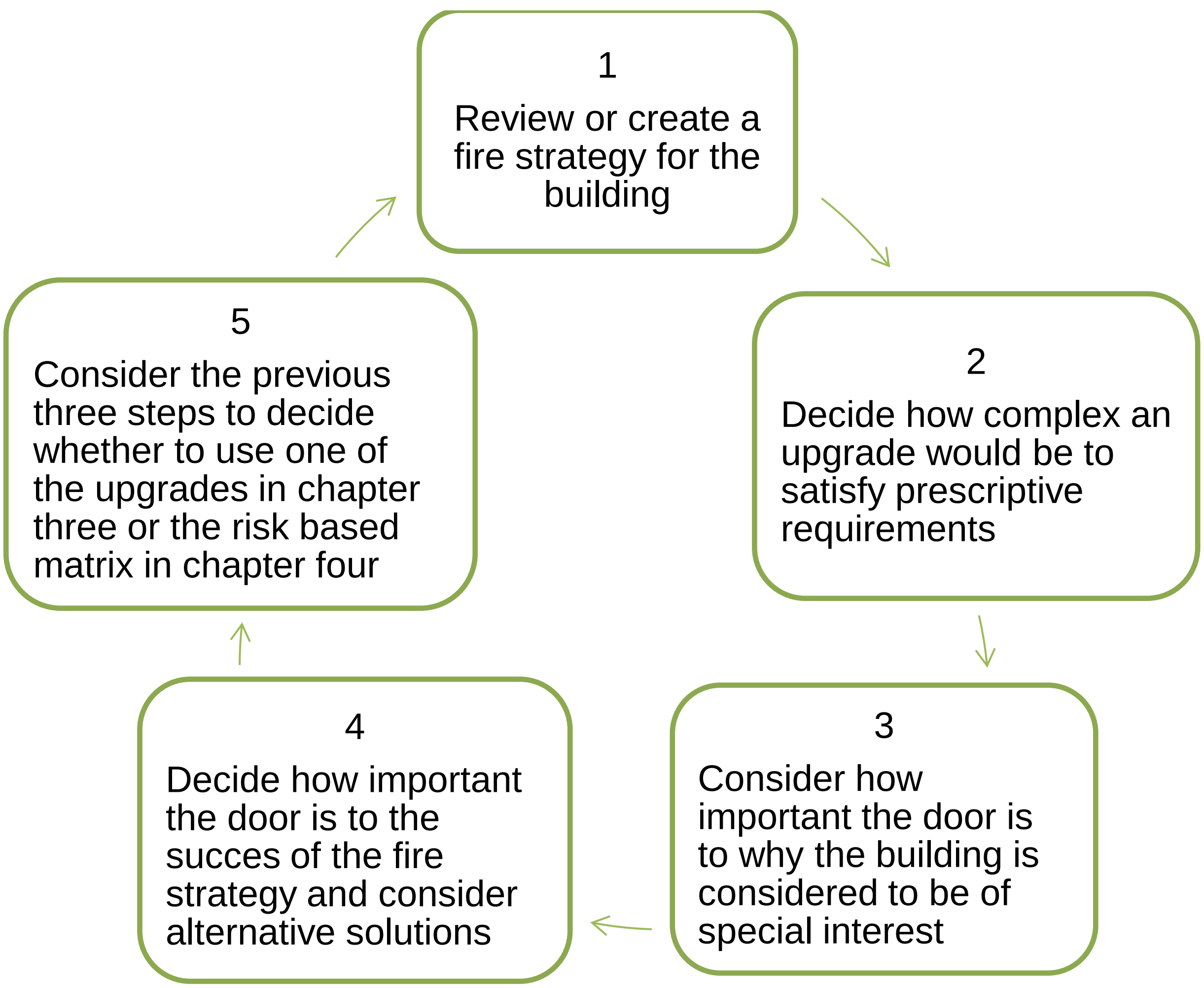
Purpose and scope of guidance

Historic doors are often relied upon to provide a degree of fire and smoke resistance, but there may be conflict between the parties involved in the decision making process. There are those seeking to improve the fire performance of the doors and those tasked with protecting the historic fabric and character of the building.

This document seeks to clarify the process of deciding if changes are necessary, the degree of upgrading to a door and what could be done to satisfy all points of view, including enforcement authorities. The upgrading section is limited to single swing panel doors, but the remainder of the document can be applied to other types of door.

Diagram 1

Decision making process



Design of Doors and Frames

The design of doors and frames has evolved over thousands of years, because of a variety of factors, the most probable being

- Availability and cost of materials
- Improved facilities for working with timber
- Our understanding of how to design doors which best accommodate the inherent characteristics of timber
- Changes in style and taste

The principles of design have changed very little since the eighteenth century.

Plank Doors

Plank doors are the earliest type of door still seen today. They are thought to have emerged during the Neolithic period and are constructed by joining several full height timber members with horizontal ledges or rails to keep them together (ledged door)[1].

If the planks and ledges are wide enough and securely fixed together, the latch edge will not drop and the door will remain relatively square.

Where additional security or solidity was required horizontal planks were fixed across the back of the vertical members making the door very heavy, but combated the tendency to drop and warp.

Narrower planks and ledges do not have sufficient space to adequately fix together to give the same rigidity, so need bracing by a timber member at 45^0 rising from the hinge side to support the latch edge.

Single plank door. Ledges have been added to reinforce the shakes

Ledged door shaped to fit sloped ceiling. The ledges are wide enough to keep the door square

Ledged and ledged and braced doors are susceptible to warping from environmental changes and often have adjusted stops to accommodate the twist of the door.

Framed doors

To allow narrower planks to be used and to prevent warping, they were fixed to thicker timbers at the edges of doors, to become framed ledged and braced doors.

In the Tudor period frames became more elaborate particularly in churches and castles with intermediate members fixed with mortice and tenon joints. The frames superseded the planks in giving strength and rigidity to the doors.

Sturdy frame supporting vertical planks

Framed, ledged and braced door

The additional weight of some doors and frames were sometimes supported by elaborate strap hinges which gave a more ornate finish.

Strap hinge bracing vertical planks

Panel Doors

It was not a great leap in design to replace the vertical planks with infill panels. This occurred as techniques and hand tools improved; the now familiar panel design developed, incorporating mortice & tenon jointed framing members and infill panels.

Simple two panel door
With raised and fielded panels

This new form of construction gave two important performance characteristics:

- Greater stability and resistance to distortion

- Ability to accommodate shrinkage and expansion of the timber members without significantly affecting the door as a whole.

These characteristics are equally beneficial when the door is required to provide a level of fire resistance.

Flush Doors

Relying on the frame to provide stability and strenth paved the way for the introduction of the modern flush door.. In the 1950s domestic panel doors were commonly covered with plywood or MDF to give a modern look and remove the dust traps that the panels and beading created. Modern flush doors have stiles and rails to form the outside edges and veneered fibreboard or plywood for the skins. They have either a solid or hollow-core. The first moulded door was introduced in the 1920s with the discovery of compressed fibreboard

Hollow core doors often have a lattice or honeycomb made of corrugated cardboard, extruded polystyrene foam, or thin wooden slats to stop them sounding hollow. They can also be built with staggered wooden blocks. These types of door give very little fire protection because of rapid burn through of the skin.

A solid block of wood (lock block) provides a solid and stable location for mounting the door's hardware.

Solid-core doors can consist of low-density particle board or foam used to completely fill the space within the door.

The core of fire resisting doors can include particleboard, flaxboard, chipboard, and solid timber. They are commonly used as exterior doors because they provide more insulation, strength and stability.

Horizontal planks fixed to vertical planks resist warping, but can be heavy

Four panel door provided good protection from a severe fire

Diagonal planks and Elaborate frame

Although older doors and frames were not designed for fire protection, there are some cases where only minor modifications, as shown on pages 14-18 are required, particularly to panel doors to provide 20 or 30 minutes fire resistance in a fire test.

The most appropriate and sensitive methods of upgrading will require some understanding of the inherent strengths and weaknesses of the construction.

Chapter 2 Factors affecting the performance of doors and frames

Doorsets tend to fail the integrity fire resistance test of BS 476: Part 22 and BS EN 1634-1 and 2 for one of four main reasons

- Distortion of the door at its junction with the frame, particularly the top corners, allowing the passage of flames.
- A weakness in the door construction, usually occurring at the junction of panels with the frame or joints in the panel
- Burn through of thinner part of panel or frame, perhaps where large items of door furniture are fitted.
- Burn through at the gap between the door edge and the frame

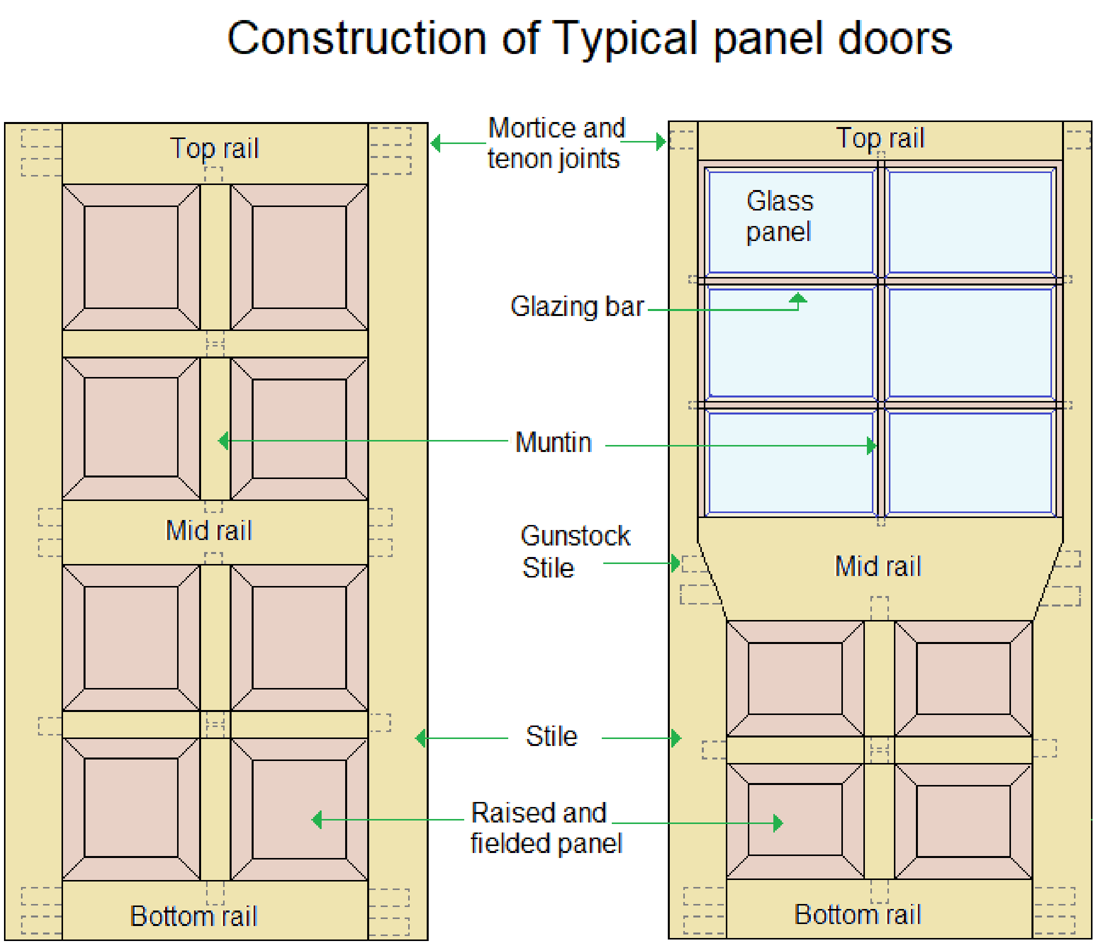


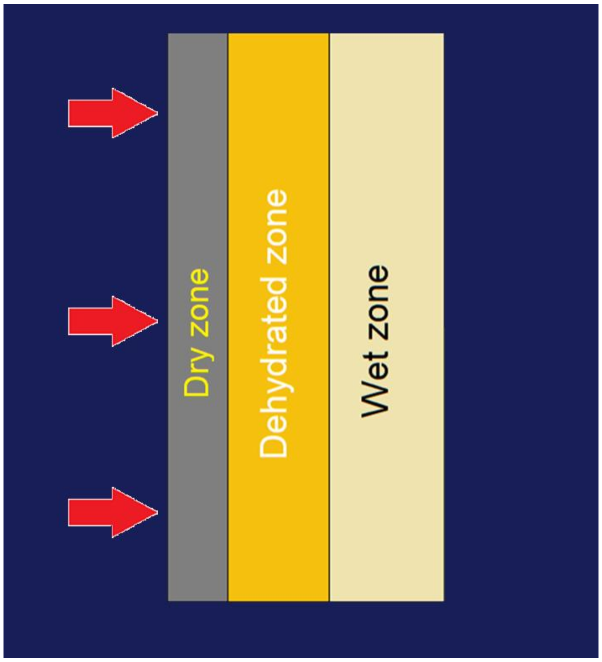
Diagram 2

Distortion

During a fire the exposed face of the door dries out and shrinks causing the door to bow, pulling the edges of the door towards the fire.
The top corners of the door are the most critical areas as they are exposed to the most heat and pressure during a fire.

The photograph below shows the moisture from the exposed face of the wooden panel rising to the top edge and evaporating. The heat from the blow torch is central to the panel so the evaporation at the top is mainly in the centre.
The exposed face becomes dry, the layer of wood behind it becomes dehydrated and unexposed face remains hydrated at its original moisture content.
The distortion of this panel is exagerated because it has been cut from the centre of the tree giving a tight curve to the grain.

Diagram 3
Zones of moisture in wood during a fire



Panel of wood exposed to butane torch showing moisture (sap) evaporating

Structural Stability

The structural stability of the doorset is affected by

- The relationship between the height, width and thickness of the door
- The size of the stiles and rails
- The quality of the timber, i.e. the straightness of the grain, absence of knots and shakes, the direction of cut.
- The quality of workmanship
- The method of construction

The distortion of the door will increase as the door size increases in relation to the size of the stiles and rails.

The hinges and intumescent strips on the door edges and top help to resist the tendency to warp. The cold smoke seals burn away before the intumescent has fully expanded, so do not contribute to the stability of the door.

Uncertainties with assessing the fire resistance of door sets

Heritage bodies[3] have been testing doors and panels for the last sixty years. The uncertainty of determining how a particular upgrading method will perform has become increasingly obvious. Please see pages 29 and 30 for examples.

Charring rate of timber

The charring rate of different timbers whilst giving an indication of how long a door will last in a fire is not very accurate. It varies with the timber species and density, what part of the tree has been used, the moisture content and testing regime.

Wood also chars more quickly with higher temperatures at the top of the door and during the peak of the fire growth curve and less at the incipient and decay stages of the fire. The following table can therefore only be assumed to be a rough guide to the differences in species.

Table 1 [4]

Typical Charring Rate of Timber

Oak	0.63mm / min	38mm/hour
Pine	0.98mm/min	59mm/hour
Spruce	1.1 mm/min	66mm/hour

The fire resisting properties of existing panels depend on the subtle differences between them. These differences dictate the available methods of upgrading and the performance of the upgraded panel.

Burn-through of the panel material is affected by

- Panel thickness
- Panel height and width
- Method of jointing the panel
- Panel design (eg flat, raised and fielded linen-fold, etc.)
- Species and density of timber
- Condition of timber
- Natural features such as knots, splits, etc.

Burn-through at the perimeter of the panel is affected by

- The size and method of fixing the beads
- The degree of panel shrinkage which has already occurred.

- The size of the channel into which the panel is fitted.
- The detail of the intumescent material around the edges of the panel.

Methods for determining fire resistance performance

British Standard 476: Part 22 and BS EN 1634-1 and 2: define the test conditions and criteria for determining the fire resistance of timber doorsets.
The results are expressed in terms of *integrity* (essentially the prevention of the passage of hot gases and flames) and *insulation* (prevention of an excessive temperature rise on the non-risk side).

The BS EN test is more severe than the BS476 test as the method of measuring temperature leads to an increased severity in the early stages and it specifies that the neutral plane in the pressure gradient is closer to the floor. However the conditions in the test rig are more severe than would be expected in a real fire, so successful testing to BS476 will give a satisfactory performance.

The testing regime for fire doors is set so that the conditions in the test rig are the same wherever and whenever the test takes place. This enables doors from different manufacturers to be fairly compared whichever test house undertake the tests.

The time temperature curve is more severe than a real fire as shown in diagram 6. This can be seen in the early stages of development and post flashover, where the temperature continues to rise rather than fall due to the consumption of fuel or oxygen.
It could be inferred that the difference between a real fire and the test fire gives a higher safety margin. Conversely it could be argued that the matrix described on page 34 and appendix 4 is already conservative, so no additional safety margin is required.

Insulation performance is important on doors in compartment walls because conducted and radiated heat can ignite materials stored against or near the door. Fire resisting doorsets on escape routes do not have to meet the insulation criteria, as it is unlikely that combustible materials will be stored against a door that is in use.

Testing from risk side. As heritage doors are fitted in known locations and the risk side can be determined, the door can be tested on the risk side only rather from both sides.
If the doors are non-symmetrical and their position in a building is unknown testing from one side is not acceptable as their fire resistance performance is required from either side separately.

Methods for determining the cold smoke resistance performance

British Standard 476: part 31.1 and BS EN 1634-3 define the testing regime to determine the ambient smoke resistance performance of doorsets.

When assessing the likely performance of a doorset, it is important to check the configuration in use is the same as that tested.

The maximum permitted leakage rate of the standards is 3 cubic metres per hour per metre of the perimeter of the door, when tested at 25 pascals. This is in line with the recommendations of Approved Document B of the Building Regulations.

Chapter 3 Upgrading of Fire Doors

This section of the guidance is to show some methods of upgrading, where the room size is below 50m³, or the use of the matrix in chapter 4 has shown that it is necessary.

This part of the guidance is limited in scope to single swing, single leaf doorsets, within the dimensions shown in table 2. Doors outside these limits may be upgraded using similar methods, but are likely to have a reduced fire resistance period.

When the thickness of the door is insufficient for the fire resistance performance required, it may be possible to increase the thickness by fixing on stile, rail and muntin members and upgrading the panels with one of the methods shown in table 3. However, this is a very intrusive intervention and approval by the conservation officer should be sought. Alternative approaches would be to change the use of the room, or the fire loading, so that the door does not require such drastic changes to its design.

Table 3 shows various methods of upgrading and securing panels, which are applicable where the door is no larger than the dimensions shown in table 2

- The door is single leaf and at least 30mm thick
- The panel beads or grooves into which the panels are retained are at least 12mm in width and depth

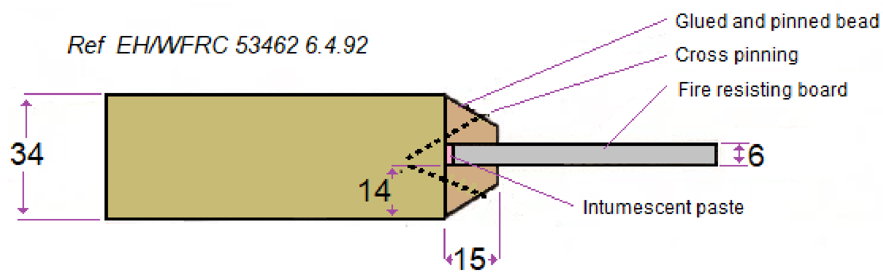
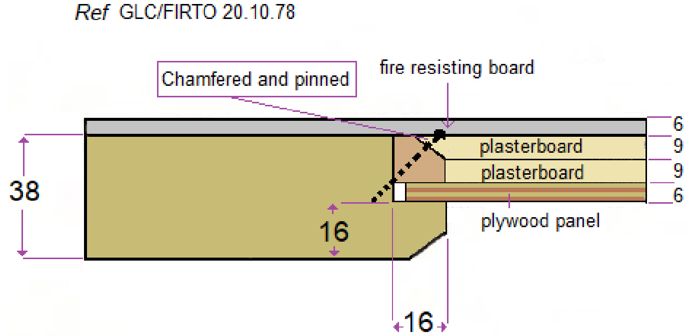
Some methods of upgrading do not place any reliance on the existing panels, while some less visibly intrusive methods of upgrading rely on the inherent fire performance of the panel. The latter methods require careful analysis of the panels before being used.

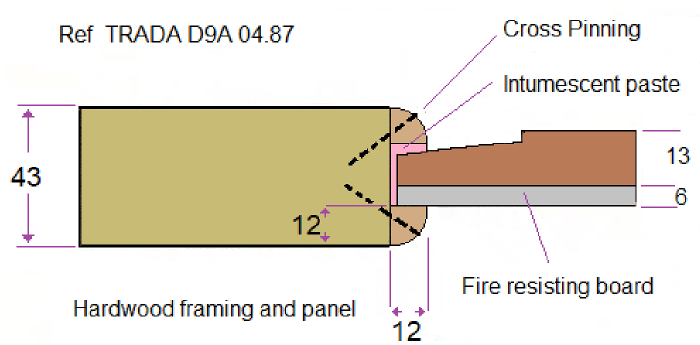
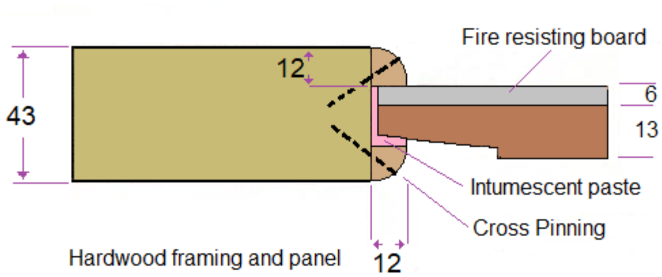
Upgrading solutions using intumescent paints and varnishes have been omitted from this guide because of the variations that can occur in their application. If such applications are considered careful analysis of fire resistance test evidence for the inclusion of the upgrading methodology, alongside a control sample

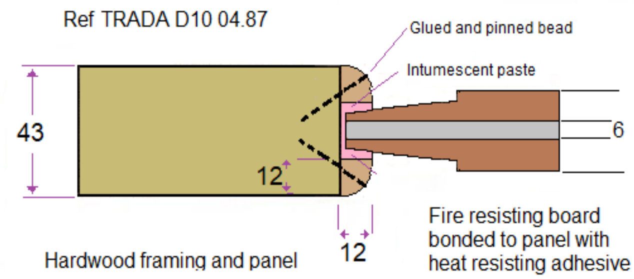
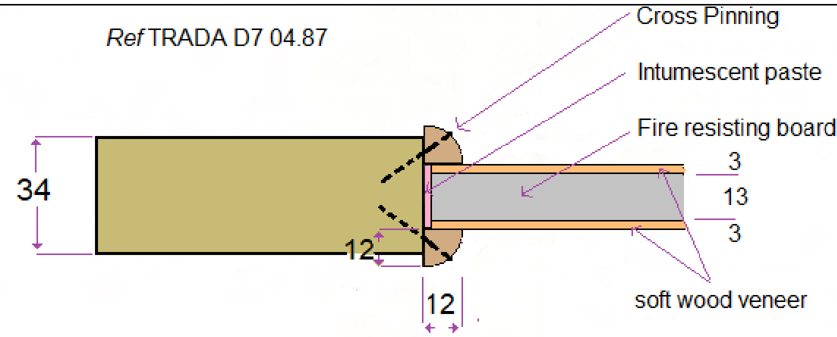
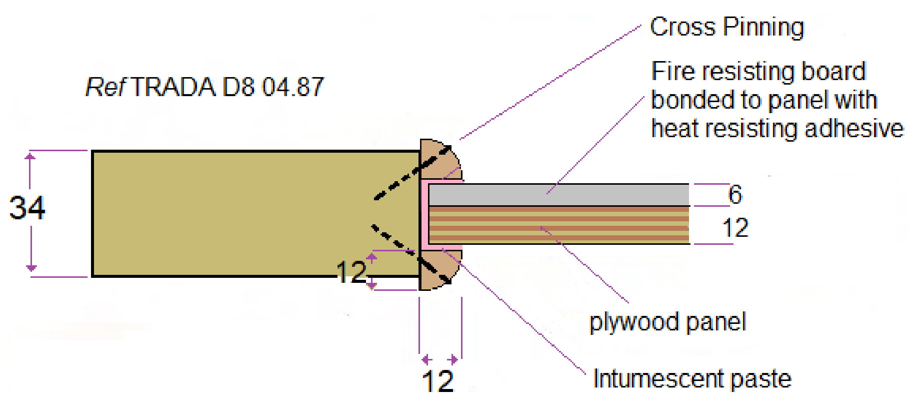
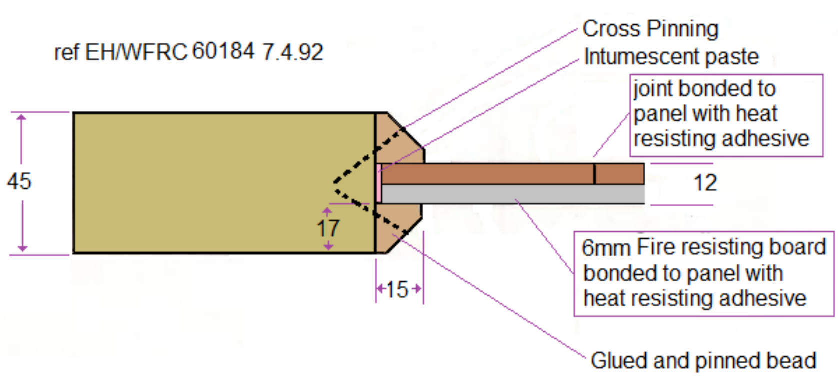
Table 2[5] Limiting dimensions for door leaves constructed from timber of minimum density of 450 Kg/m2 and comprising at least 2 panels

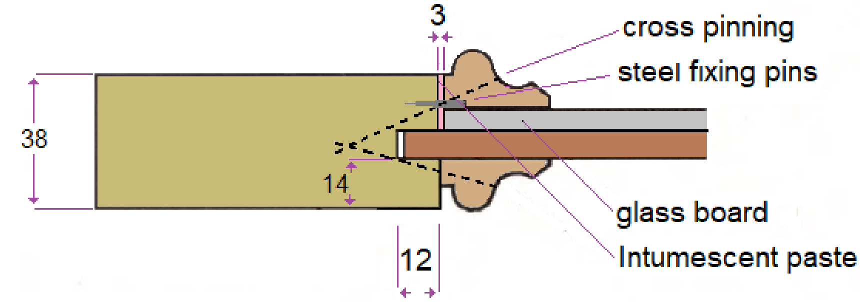
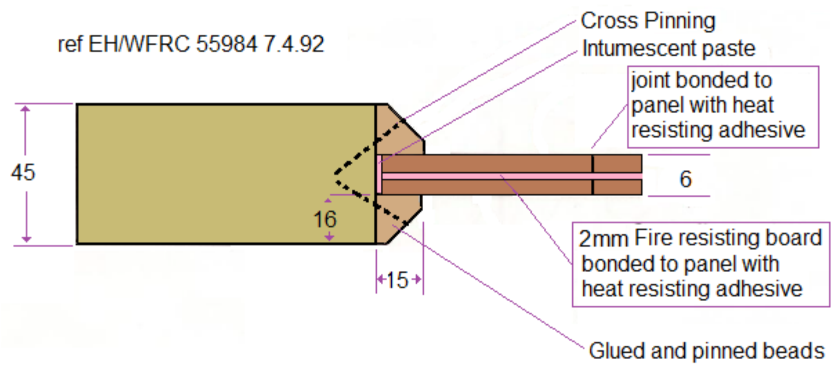
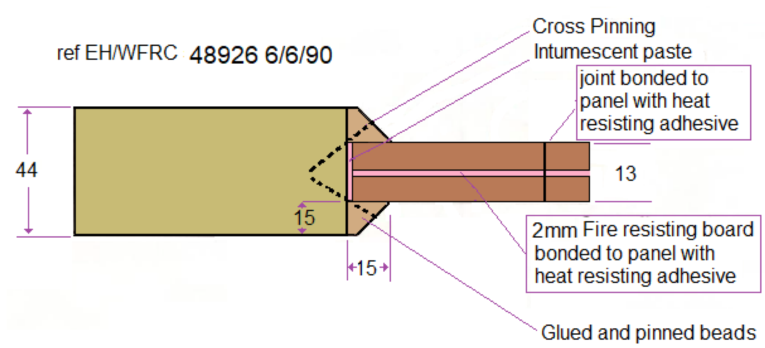
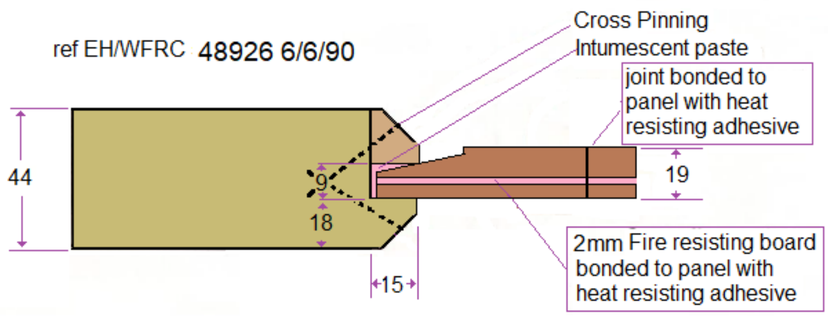
Fire resistance performance (integrity) [minutes]	*Minimum leaf thickness (mm)*	*Maximum leaf width (mm)*	*Maximum leaf height (mm)*	*Minimum width of stiles and top rail (mm)*	*Minimum width of mid and bottom rail (mm)*
30	35	800	2055	100	200
30	40	900	2000	90	150
30	45	950	2100	80	150
30	45	890	2295	100	200
20	35	900	2000	90	150
20	40	950	2100	80	150

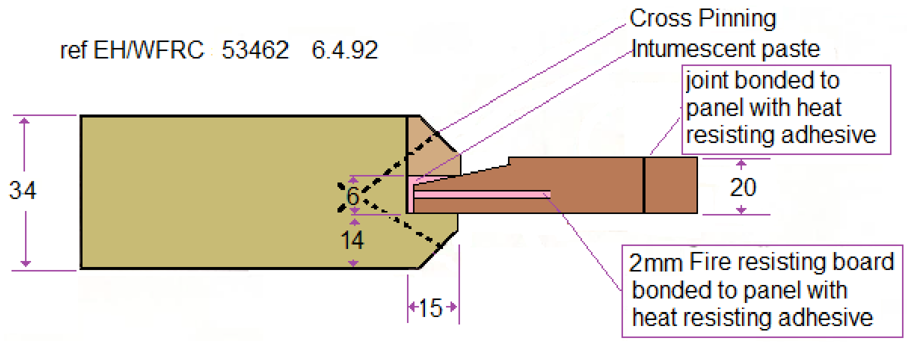
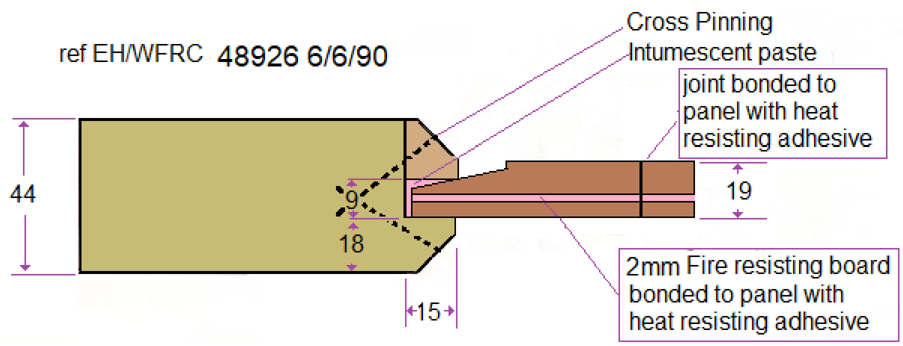
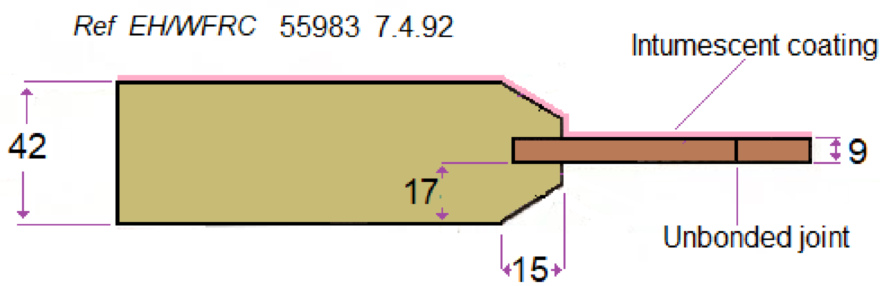
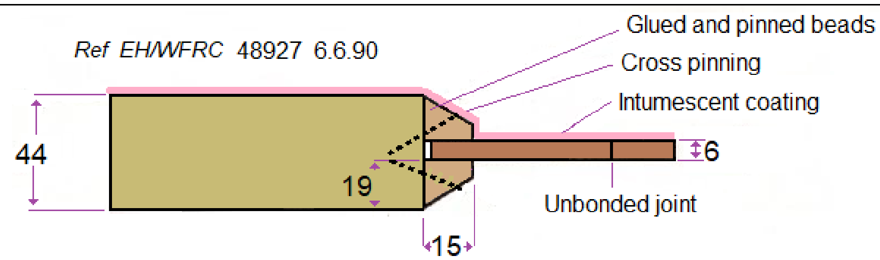
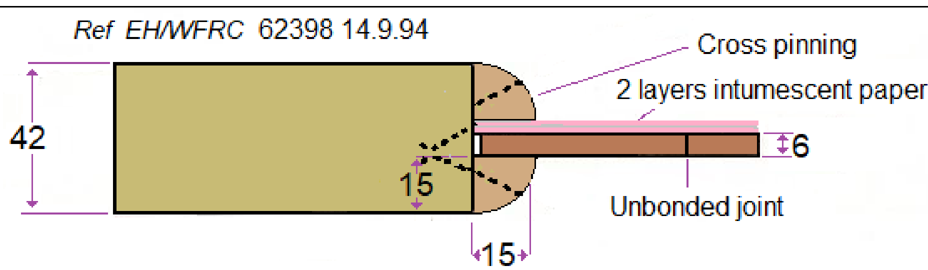
that demonstrates how much of an effect
the upgrading method gives.

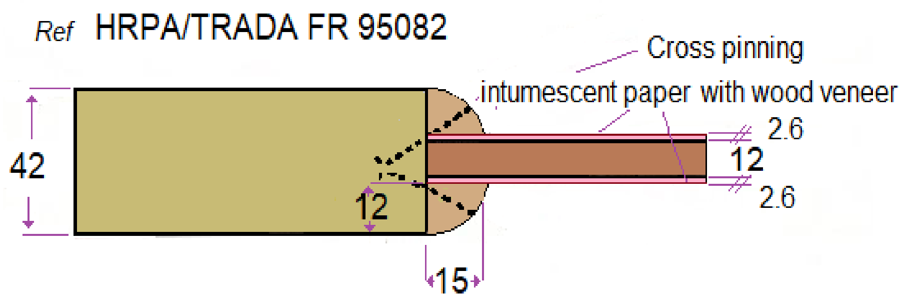
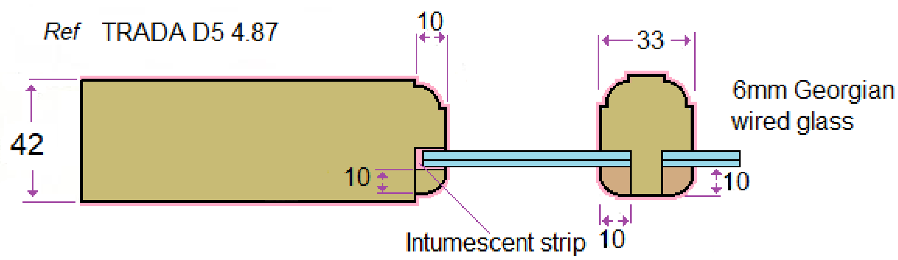
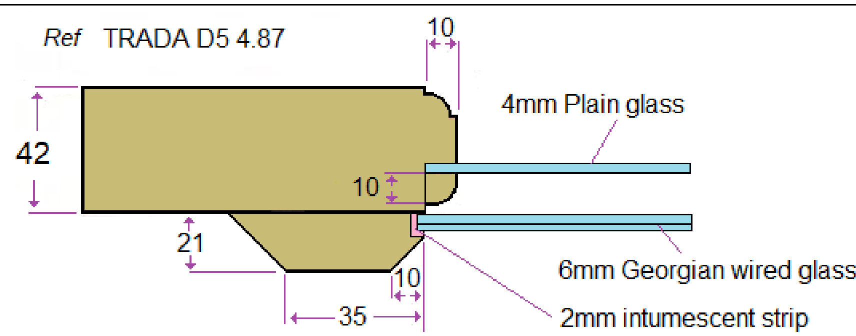
<table>
<tr><td></td><td>Diagram 4[6] Test Results with top face exposed to fire</td><td>Results in Minutes & location of failure</td></tr>
<tr><td>A</td><td>
</td><td>29</td></tr>
<tr><td>B</td><td>
</td><td>28

Location of failure door leaf/frame junction</td></tr>
<tr><td>C</td><td>
</td><td>30</td></tr>
<tr><td>D</td><td>
</td><td>21</td></tr>
</table>

E		**30**
F		**30**
G		**30**
H		**30+**

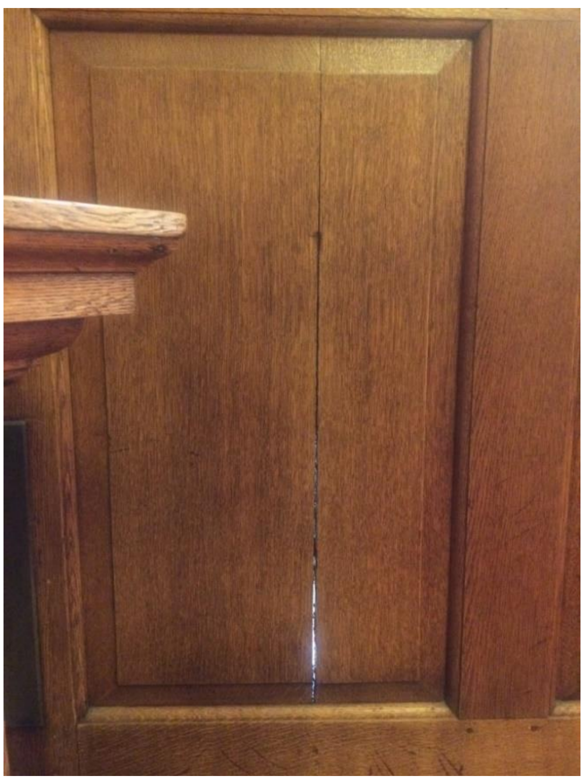
I		**27** Location of failure: panel/frame joint
J		**23** Location of failure: burn through of panel
K		**30+**
L		**30+**

M		**29.5** Location of failure: burn through of panel
N		**30+**
O		**11** Location of failure; panel joint
P		**17** Location of failure: panel/frame joint
Q		**30+**

R	 Ref HRPA/TRADA FR 95082 Cross pinning intumescent paper with wood veneer 2.6 12 2.6 42 12 15	**30**
S	 Ref TRADA D5 4.87 10 33 6mm Georgian wired glass 42 10 10 Intumescent strip 10	**30**
T	 Ref TRADA D5 4.87 10 4mm Plain glass 42 10 21 10 6mm Georgian wired glass 35 2mm intumescent strip	**30**

Cross pinning is often used to secure the panel beads, irrespective of whether they are integral or separate. This helps retain them and the glazing in position when the intumescent material, used to bed in the panels, activates during a fire.
To prevent splitting, the panels need to move independently from the framing components of the door, when responding to environmental changes. It is therefore important that the panels are not inadvertently fixed in position by pinning, bedding in, gluing, varnishing or painting.

Varnish causing the panel to bind and being stretched by the mid rail so it splits



Gaps between the door and frame

The gap between the door and frame is one of the weakest areas of a doorset as the pressure of the fire seeks to exploit it.

The doors should fit squarely and neatly within the frame. The gap at the top and both edges of the door should not be wider than 4mm or the width of the cold smoke seal used and the ability of the intumescent material to fill it when it activates. Any excessive gaps, or distortion may be rectified by

- adjusting the hinges and, or
- applying a lipping to the appropriate edge or edges.

When applying a lipping the door edge should be planed flat, to ensure a clean even surface. Always use heat resisting adhesive, such as urea formaldehyde for bonding the lipping to the door edge. The timber used for the lipping should be the same type and density as the remainder of the door.

The top rail of this door should be planed flat, then lipped and routered to provide a groove for the intumescent strip.

Lipping the top of the door or frame puts the repair in the most critical part of the door set during a fire. If the door can be raised by adjusting the hinges, the lipping can be applied to the bottom of the door.

Any weaknesses caused by moving the hinges should be repaired in a similar way to the lipping. If the door remains square and the building has moved, the lipping could be applied to the underside of the doorframe.

In this example the building has moved, so it may be more acceptable to fix the lipping to the frame, rather than the door.

However, if the top rail is large enough to retain the strength of the mortice joint, it might be possible to

a) plane the top of the rail so that it is parallel to the frame
b) raise the door by moving the hinges
c) plant a fillet of wood to the base of the door

Gaps at the bottom of the door

The gap at the bottom of the door allows the inward passage of air to ventilate the fire and whilst is not normally attacked by heat and smoke (see photographs on page 33) can increase the amount of smoke that spreads throughout a building..

When the smoke layer builds down close to floor level, the fire becomes ventilation controlled, starts to cool, further reducing the smoke and gases, and when they are at ambient temperature, the pressure becomes ambient and reduces the likelihood of the gap being exploited by cold smoke for the duration of an evacuation. (see appendix 3)

To limit the passage of smoke under any door, the potential for installing threshold sealing should be considered. .

Gap caused by the removal of a carpet should be reduced with timber lipping glued and screwed to the base of the door.

Diagram 5 *Gap beneath door caused by sloping floor*

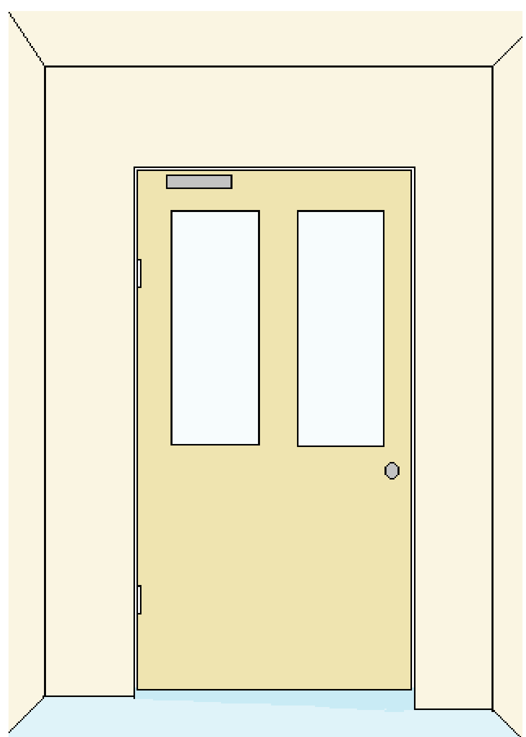
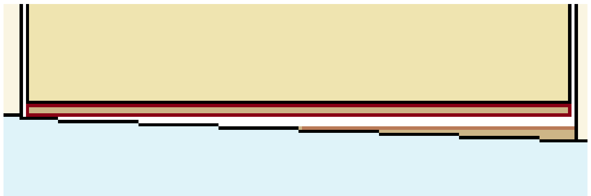


Diagram 6 *Timber lipping, glued and screwed to bottom of door and threshold built up to a level that does not cause a trip hazard.*



If the gap is still too large, or the threshold is high enough to cause a trip hazard, (maximum of 15mm) the floor will need building up with a ramp on both sides.

Intumescent Strips

The door edge gap should be protected with intumescent strips. These materials are designed to swell to several times their original size when heated, to fill the gaps. The various proprietary materials differ in their expansion rate, their adhesive qualities and the pressure exerted. Those based on sodium silicate or graphite materials are particularly effective in providing a clamping action, which assists in preventing distortion of the door.

Some intumescent materials have a higher expansion rate than others; to fill larger gaps existing on particular doorsets. Suitable evidence from the manufacturers should demonstrate that their product will fill the gaps.

The top and both edges of the door and meeting stiles of double leaf assemblies should be fitted with intumescent strips.

Doors of special aesthetic or architectural significance, may have the frame rebate fitted with the intumescent strips.
Combined intumescent strips and cold smoke seals in this position, are more susceptible to damage from the leading edge of the door, so should be avoided if possible.
A suitable solution is to fit the intumescent strip flush in the frame and use “batwing or compressible tube smoke seals in the corner of the door stop. , however, care must be taken to ensure that the door still closes into the frame reveal.

Intumescent strips should not be installed within the face of the doorstop, as they may push the door open, when they expand in a fire.
Intumescent strips and cold smoke seals fitted into the stop are likely to push the door open.

The position of the combined smoke seals and intumescent strips in the door edge has been a source of controversy, because it is invasive and not reversible.

Conversely, an intumescent strip surface mounted in the frame, may require the door to be planed down to fit and 100% of the door edge will be removed, rather than less than 25% of it. The debate therefore needs to concentrate on aesthetics rather than reversibility.

Intumescent strips measuring 10mm x 4mm will be sufficient for a well-fitting, sturdy door, but where there is any doubt about the ability of the door to withstand distortion in a fire, an intumescent strip of increased dimension will give additional support.

When the intumescent material is fitted in the frame rebate, it can be surface mounted and is therefore reversible. It can also be obtained with a veneer, finished by paint or stain. However, the issue of reversibility is countered by the potential of planing down the door edges to fit the narrower opening.

The surface mounted intumescent material gives slightly better protection in the frame, than in the door edge, because there is more of it around the top corners to activate. It is also less likely to be interrupted by door furniture. However, it is more susceptible to physical damage caused by general traffic through the door and the door itself as it closes. In all cases the supplier should provide test evidence to show that their product has been used successfully in a similar application.

Ambient temperature smoke seals

Ambient temperature smoke seals are provided to help prevent smoke leaking around the door edge gaps until the intumescent material has activated, or for doors that are remote from the room on fire. The test is carried out measuring air leakage from a chamber at maximum 25 pascals which represents the pressure of the gases at the top of the room on fire.

The intent of the ambient temperature test was to limit the spread of smoke through doors remote from the room of fire origin, with further methodologies to be developed for medium and high temperature leakage. The medium temperature test has been developed in Europe but is infrequently used, at present.

In practice there is a heat and pressure gradient within a fire compartment and the seals are designed to limit smoke leakage at a range of temperatures higher than ambient and pressures higher than atmospheric. They will often burn through, sometimes producing smoke, before the intumescent has expanded to fill the gap, but this should be after the building has been evacuated.

Durability

Doors in constant use should be provided with smoke seals that can withstand extended use without damage.
Where there is the possibility of mechanical damage, because of the use of trolleys or wheeled beds etc. the smoke seals chosen should be the type which can be sited in the protected area of the frame.

Batwing smoke seal in corner of doorstop

Ability of the smoke seals to seal variable gaps.

When retrofitting smoke seals to existing doors and frames, the doors often tend to be ill fitting, with gaps, which vary around the door edge. The doors should be rehung as squarely in the frame as possible. The smoke seals chosen should make contact with the door edge or face if they are mounted in the frame, or with the frame if they are mounted in the door edge. There are a variety of widths of seal, and the correct width should be chosen to seal the gap, without the door being too tight to close easily.

Types of smoke seal

There are four main types of smoke seal;
diagram 7 Brush seals,

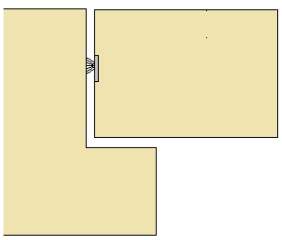


Diagram 8 Blade seals,

Batwing *“wiper blade”*

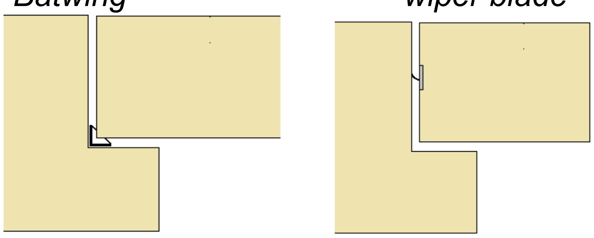
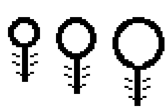
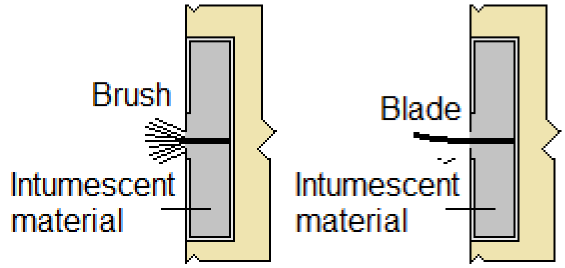


Diagram 9 Compression seals



Combined intumescent and cold smoke seals, which are usually a combination of the blade or brush seal with an intumescent material encased in aluminium or plastic. Diagram 10



Other Gaps

The 25 mm (one inch) doorstops used by some contractors do not improve the fire resistance or smoke-stopping ability of the door set. The original appearance of the doorframe could be restored by the removal of existing planted 25mm stops, when the smoke seals and intumescent strips are fitted.

Where gaps exist between the stiles, rails and muntins, because the joints have opened up, the gaps should be dealt with by

- Applying intumescent mastic to small gaps up to 2mm across
- Opening up the joints and rebonding them with urea formaldehyde adhesive.

Damage to doors caused by wear and tear or the removal of timber to accommodate previous locks, or other ironmongery should be repaired by inserting and gluing wood of the same density.
Gaps around the frame should afford the same protection as the doorset.

This doorset is completely compromised by the ceiling void and light fitting above

Warped doors

Doors should sit fully within their frames, but if they are warped, it is more important that the top of the door, is completely flush than the bottom. The top is the weakest point, where the fire is more severe. Fire tests have shown that as long as the intumescent strip is within the frame when a door is partially held open (up to 15mm), it will still give a satisfactory performance.

Constant wedging of self-closing doors will cause warping. Where the door is excessively warped, it can sometimes be remedied by one of the following methods.

- Adjusting a pinned or screwed doorstop and rehanging the door further into the frame.
- Adjusting the hinge positions to allow the door to fit more snugly within the frame.
- Attempting to flatten the door by placing it on a flat surface and applying an even load to the face of the door for several days or even weeks. If the door is successfully straightened, it should be carefully monitored after rehanging, to ensure that it remains true.

Ironmongery

Mortice locks, especially if they are poorly fitted may contribute to the premature failure of a door, although the insulation properties of timber are such that only on thinner doors will additional protection be required.
Letterboxes, keyholes and other door furniture that penetrate completely through the door leaf will require additional protection, as they would otherwise provide a direct path through the door for the passage of fire.

Self-Closing Mechanisms

Fire resisting doors should either be self-closing or should be kept locked shut, unless management procedures, which have been decided upon as part of the fire risk assessment and emergency strategy, are in place to allow doors to be closed manually in case of fire.

Overhead closers or floor springs have proved over time to be the most reliable types of self-closing device and are therefore recommended in preference to other devices which may require more frequent adjustment to remain effective.

These self-closing devices should close the door effectively, overcoming the resistance from seals or the latch.
Self-closing devices should have test evidence to show that they will give a satisfactory performance during a fire test in the same doorset configuration being considered.
Overhead self-closing devices, which are fixed onto the face of the door, will be subjected to a variety of fire conditions

- On outward opening doors, where the self-closing device is fitted to the risk side of the door, it should be capable of withstanding the effects of the fire and keep the door closed for the duration of the test.

- On inward opening doors, where the self-closing device is fixed on the risk side of the door, although it will be exposed to the fire, the positive pressure created will help to keep the door closed.
- Where the self-closing device is fitted to the unexposed face of the door, it will not be subjected to the extremes of temperature, which could cause premature failure, unless above uninsulated glass panels.

In all these instances the doors should self-latch, unless the self-closing devices have been tested on unlatched doorsets.
The intumescent material between the door and the frame will also help to hold the door in place upon expansion.

Automatic Hold-open devices

When there is a requirement to keep a fire-resisting door in the open position, it should be fitted with an automatic hold-open device, which releases on activation of the fire alarm system.
The use of wedges to keep doors open not only defeats the object of making them fire resistant, but can cause warping. The force of the self-closing device is counteracted by the wedge acting on the opposite corner of the door causing stress on the stiles and rails.

Electro-magnetic hold-open devices

Floor mounted electro-magnets can cause the same warping to the door, as a wedge. This can be minimised by fitting it at the head of the door, as close to the hinges as possible. This is not always easy to achieve and may necessitate the use of brackets or chains.

Magnetic device in ideal location

The mechanism should be fitted so that the release button is easily reached, or provided with a remote release button.

Hold Open Devices fitted within the Self-closing devices.

There are a variety of self-closing devices on the market, which hold the door in the open position, or allow it to swing freely, until the fire alarm actuates. These devices do not impose any extra stresses on the door and are therefore preferable to other methods of keeping the door open.

If the hold-open self-closing device relies on the sound of the fire alarm system, the audibility should be checked to ensure that it is sufficient to trigger the device.
Voice alarm systems do not have sufficient audibility during the speech phase and the sounder phase is not usually long enough to trigger these device.

Hinges

Early hinges consisted of wrought iron straps nailed to the door with hooped knuckles hung on hooks (pintles) attached to the masonry. They usually support doors that are face fitting, so provide very little fire protection properties.

Strap hinge hung on pintle or hook

Where doors are supported on conventional hinges, they should be capable of continuing their support during a fire, so it is advised that

- Hinges are made from steel, brass or other metal with a melting point of at least 800 ^{0}C.
- The type, location and number of hinges have a bearing on the distortion the door may suffer in the fire resistance test, but the performance of the hinges is also important for the efficient day to day working of the door.
- The hinges should be in good condition and sufficiently robust to withstand the weight of the door as well as the opening and closing strains of the self-closing device. (See BS EN1935)
- The fixings need to be deep enough (and far enough away from the exposed face of the frame and stile) not to be affected by the charring of the timber.
- Most of the heritage doors tested successfully have two hinges. An additional hinge may be required to support the additional weight imposed by the upgrading. This extra hinge should be positioned mid-way between the centre rail and the top hinge to give the most support.

For other methods of support such as floor springs or pivots, guidance should be sought from an expert in the field.

Latch and Latch Mechanisms

When comparing the performance of upgraded doors with previously tested doors, it is important that the latching arrangements are similar to those in the test. Outward opening doors often rely on a latching mechanism to keep them closed against the pressure of a fire until the intumescent material activates and helps to seal the door shut.

Doors should either be fitted with

- a self-closing device and a positive latching mechanism with a nib made of a metal or alloy with a melting point of at least 800^{0}C. Rollerball catches are not included in this category unless they were used in the test configuration.
- Where surface mounted latch mechanisms are required to keep the door closed, the screws should penetrate to a depth of at least 25mm to ensure the effectiveness of the latch for the duration of the designed fire resistance.

- a lock mechanism and a sign stating 'Fire Door Keep Locked Shut' when the door is normally kept locked.

Latch mechanisms should not cause so much resistance that they prevent the door from self-closing fully.
Stiff mechanisms should therefore be serviced and the leading edges of the strike plates should be rounded or angled to prevent hollows being worn into the sloping edge of the latch nibs.

Latch nib worn by striking plate, so the door does not self-close completely.

Recent tests have shown that standard sized mortice locks do not cause the premature failure of a doorset unless

- the door stile is weakened by the removal of too much timber, or

- the conductivity of the metal components and the direct passage for heat and smoke formed by the keyhole cause the surrounding timber to ignite.

The performance of the doorset could therefore be affected by

- the thickness of the door
- the width and height of the forend and strike plate.
- the thickness of the lock case
- the size of the gap between the lock case and the surrounding timber.

There is no conclusive evidence that the addition of an intumescent sheet, wrapped around the lock case, makes a significant impact on the fire performance of the door, possibly because of the good thermal properties of the wood. However the addition of an intumescent material can compensate for variations in the standards of work and any voids that might exist around the lock body..

Supporting construction

The supporting construction surrounding the door should provide the at least same level of fire resistance, as that required of the doorset. The structure should be in good condition to give a secure fixing for the door frame. Any defects should be effectively repaired.

Door frames are often fitted into oversize openings, leaving voids hidden behind panels or architraves. This can lead to premature failure for two main reasons

- Burn through of the materials covering the gap between the structure and the doorframe.

- Faster burning of the door frame because it is being attacked from more than one side.

Check site and records to see if voids exist between the frames and the structure. In critical situations the voids should be effectively fire-stopped
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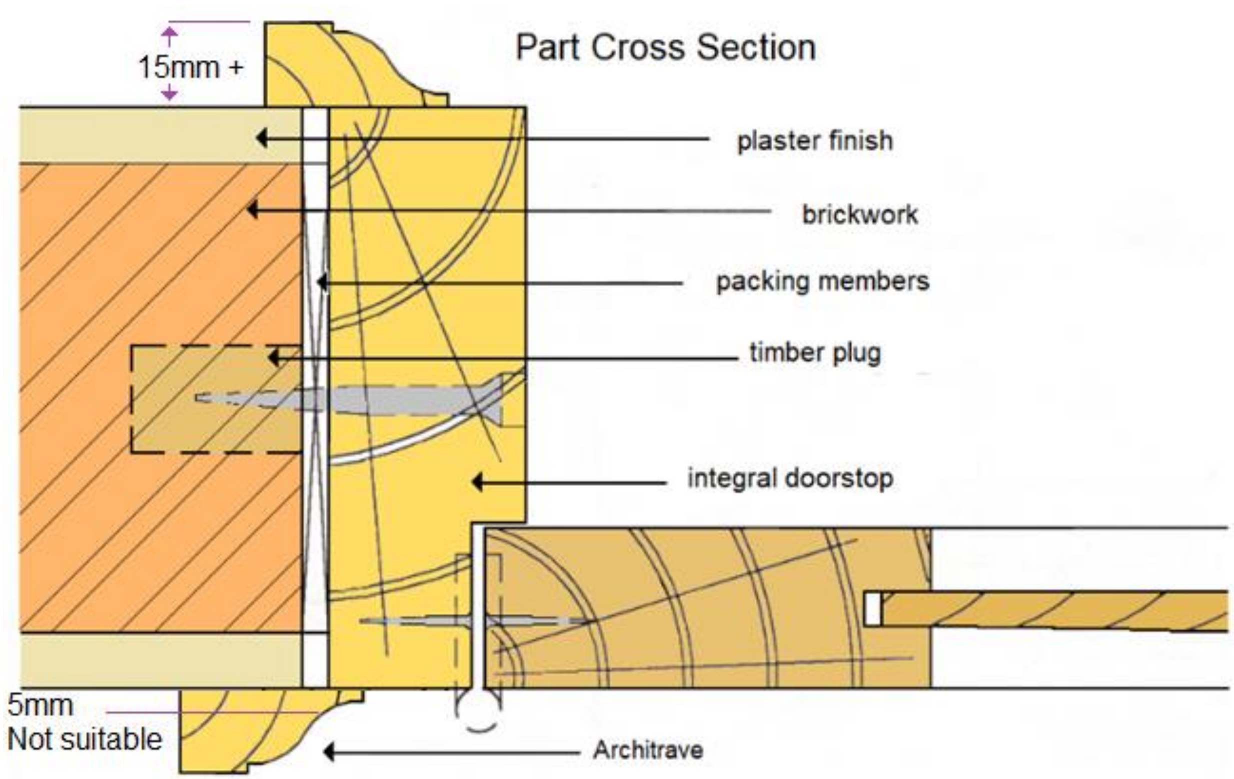

Diagram 11

Where the door frame is packed out from the supporting structure the gap should be protected by the following

- A tightly fitting hardwood architrave on both sides of the frame, which are at least 15mm thick where they cover the gap. Position of ornate architraves should be checked to ensure the widest part covers the gap. The top of the example above shows the15mm part of the architrave covering the gap, but the lower architrave has the thinner part covering the gap, which only provides 5mm of protection.
- Tight packing of the gap with mineral wool and refitting of the existing architrave with a covering of intumescent mastic along the edge before refitting the architrave.

Predicting the fire resistance of heritage doors by assessment of their construction is not an exact science, which is confirmed by a repeat of four examples of unexpected results of the tests in table 3 on the next two pages.
The exposed face (risk side) is towards the top of the page and the dimensions are in mm

Example 1

In this test the door panels were replaced with calcium silicate fire resisting board bedded into intumescent paste. Note the thickness of the door frame and beading.

This door failed at 29 minutes

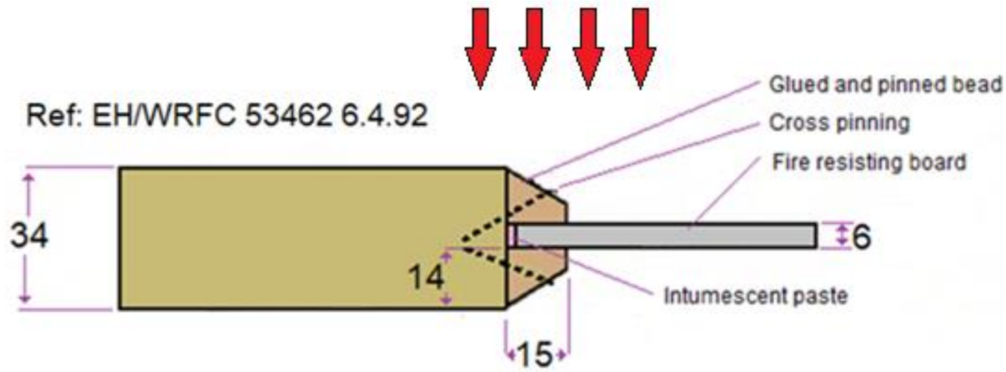

Diagram 11

Example 2

In this test the door frame is thicker, the beads are thicker and the calcium silicate board covers the whole frame and panels and has been supplemented with two layers of plasterboard, making a much heavier construction. This door failed at the junction of the door and frame.

This door failed sooner than example 1 at 28 minutes

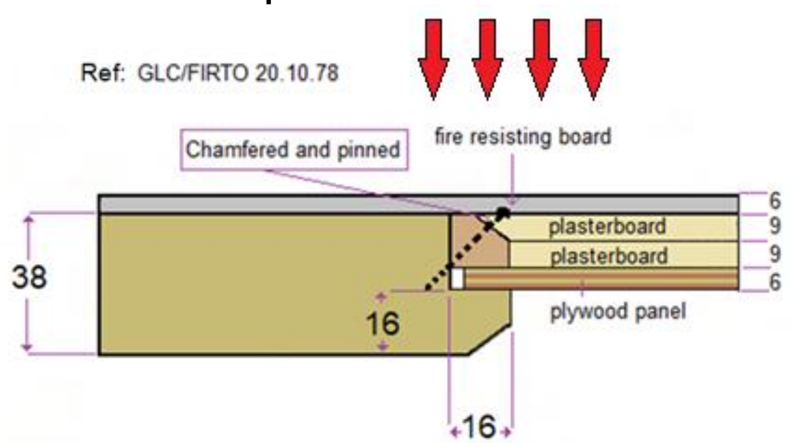

Diagram 12

Example 3

In this test the raised and fielded panel is backed with a 6mm calcium silicate board on the unexposed face of the door

This door lasted for 30 minutes

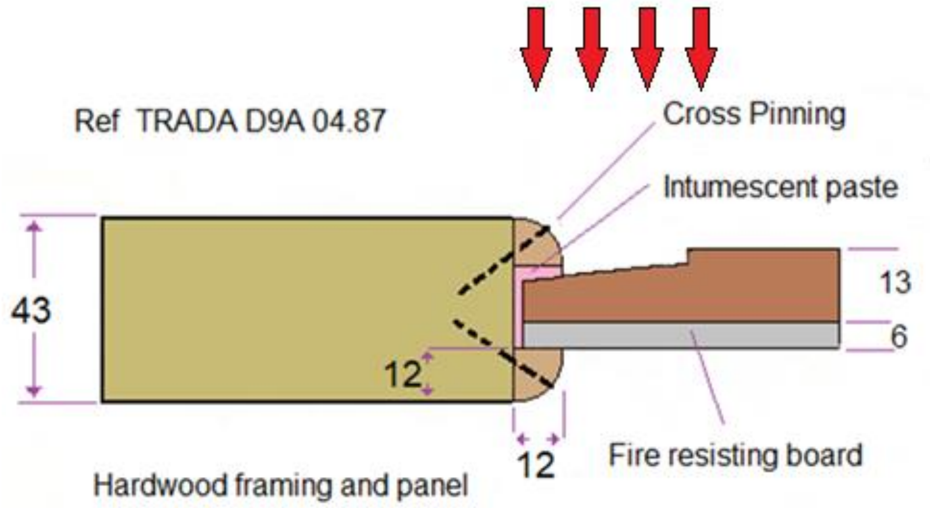

Diagram 13

Example 4

This is exactly the same as the last test, except the calcium silicate board is on the exposed side of the door.

This door failed at 21 minutes which is a counter intuitive result.

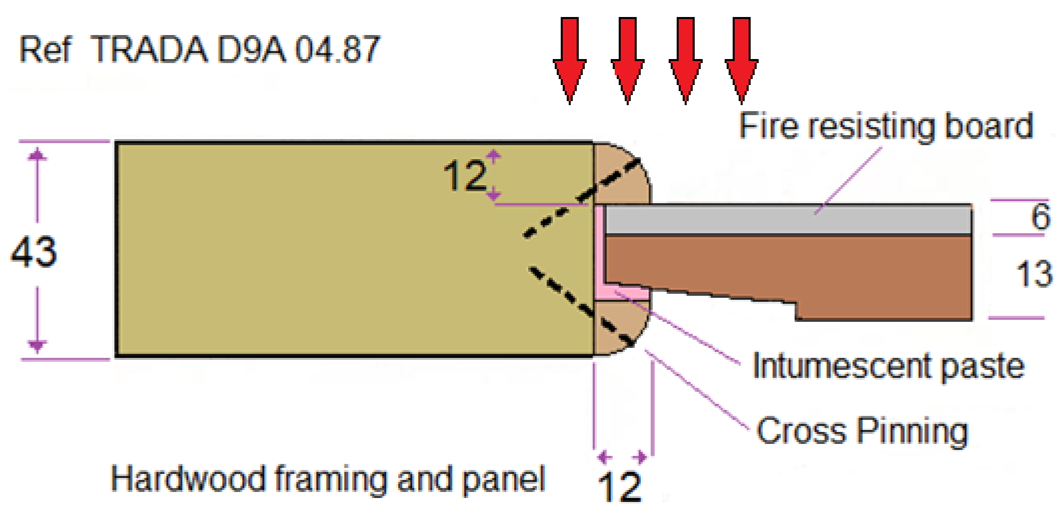

Diagram 14

Chapter 4 Design and use of the matrix

The most important factor affecting the fire performance of doors and frames is the severity of the fire to which they are exposed.

Severity of the fire

There are five main influences on the severity of a fire; room size, fire loading, disposition of the combustibles, the surface spread of flame rating of the walls and ceilings and the ventilation of the room (possibly by windows failing, which will determine whether the fire will be controlled by lack of oxygen or whether it will be free burning.

To a lesser extent the insulation characteristics of the walls and ceiling will have an effect on the temperatures reached in the fire compartment or room.

Room size determines the way that fires grow and spread.

Small rooms generally have a greater potential for fires to reach flashover than larger rooms, (if they have sufficient oxygen), because

- The fire load is greater than larger rooms with the same content.
- The packets of fuel are closer, to each other, increasing the probability of fire spread through direct flame impingement or radiated heat.
- The rising hot smoke plume reaches ceiling height more rapidly, with less opportunity for cooling by entrainment of surrounding air.
- The radiant heat from the smoke layer is closer to the unburnt combustibles and is hotter than in a large room.
- The temperature rises more rapidly, which is likelier to cause glazing to fail than a slow rise in temperature. If the neutral plane is high enough to allow fresh air in below the smoke layer the fire will become ventilated.

Fully ventilated rooms involved in fire experience higher temperatures, but shorter duration than in unventilated rooms, because the fuel is consumed by the fire and there is nothing left to burn **(**fuel load controlled).

Unventilated rooms have a lower overall temperature, but the fire can last much longer and may produce a temperature spike or backdraft when opening the door introducing oxygen.

This is caused by auto-ignition of the flammable gases in the smoke such as carbon monoxide (CO) and Aldehydes.

CO has a flashpoint of -150^{0}C and auto-ignition temperature of 321^{0}C. It is likely to be the largest constituent of the smoke and has a wide flammable limit of 12.5%-74% in air. The smoke will not necessarily reach this temperature for auto-ignition in a ventilation controlled fire.

The aldehydes will probably be at a much lower concentration, but more likely to ignite and spread to the CO, having a flammable range of 4%-60%, a flashpoint of -39^{0}C and auto-ignition temperature of 175^{0}C. This temperature is more likely to be reached in a ventilation controlled fire.

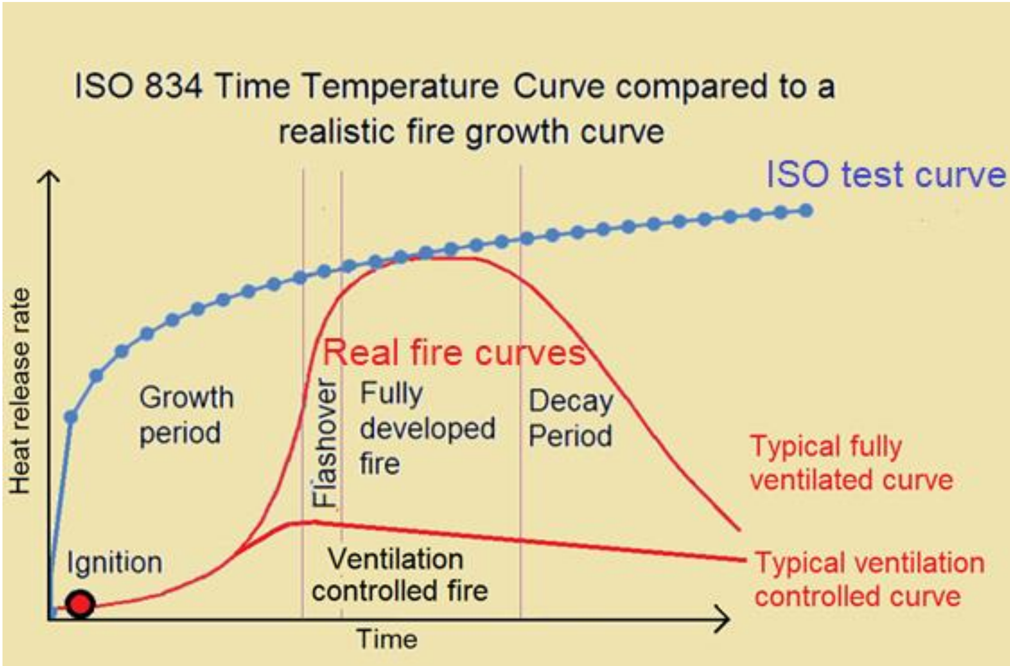

Diagram 15

The time temperature curves in diagram 7 show how a real fire differs from a fire test curve. The rise in temperature and decay is significantly different and whilst a door may fail prematurely under test conditions, it may last longer in a real fire.

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Appeal to Secretary of State following introduction of Fire Safety Order.

In 2006 the risk assessment based Fire Safety Order replaced all previous fire legislation.

Subsequently some enforcing authorities began using the fire risk assessment guides to the Fire Safety Order prescriptively.
An opportunity arose to challenge an Enforcement Notice on a Grade 1 listed hotel which required some bedroom doors to be upgraded. It was agreed with the enforcing authority that an appeal should be made to the Secretary of State for Fire on the grounds that;

- The hotel had a Fire Certificate under the Fire Precautions act 1971, issued two years earlier by the fire authority certifying that it was safe.
- The corridors had cross corridor fire door every 4 bedrooms, thus limiting the travel distance to a place of safety.
- Most importantly the bedrooms were double the size of bedrooms in other hotels, so any fire occurring there would be slower growing and the doors would not burn through initially, allowing time to escape from the adjacent bedrooms.

Unfortunately the appeal was rejected, because the doors did not meet the guidance in the government's guide "Fire safety risk assessment for sleeping accommodation" and the doors had to be upgraded.

Subsequent actions

To avoid the results of the appeal being used as a precedent for other buildings, National Trust commissioned a fire consultancy to undertake CFD modelling of large rooms to show that doors would not be affected in the early stage of a fire. Their report, "Upgrading the Fire Resistance of Existing Historically Significant Doorsets, A Risk Assessed Approach" showed that the incipient stage of fire growth would increase with room size. See appendix 1

This was followed by a dissertation "Assessment of Fire Loads and Severity in Heritage Buildings" by Simon Vickers which looked at fire loadings in heritage settings and modelling of fires which led to the real fire testing below.

Fire testing

Fire tests, completed in 2013 were to confirm the findings of earlier computer modelling on the effect of room size on fire growth. The reason for these fire tests was to find a way to avoid the unnecessary alteration of historic doors for fire protection reasons, particularly in large rooms.

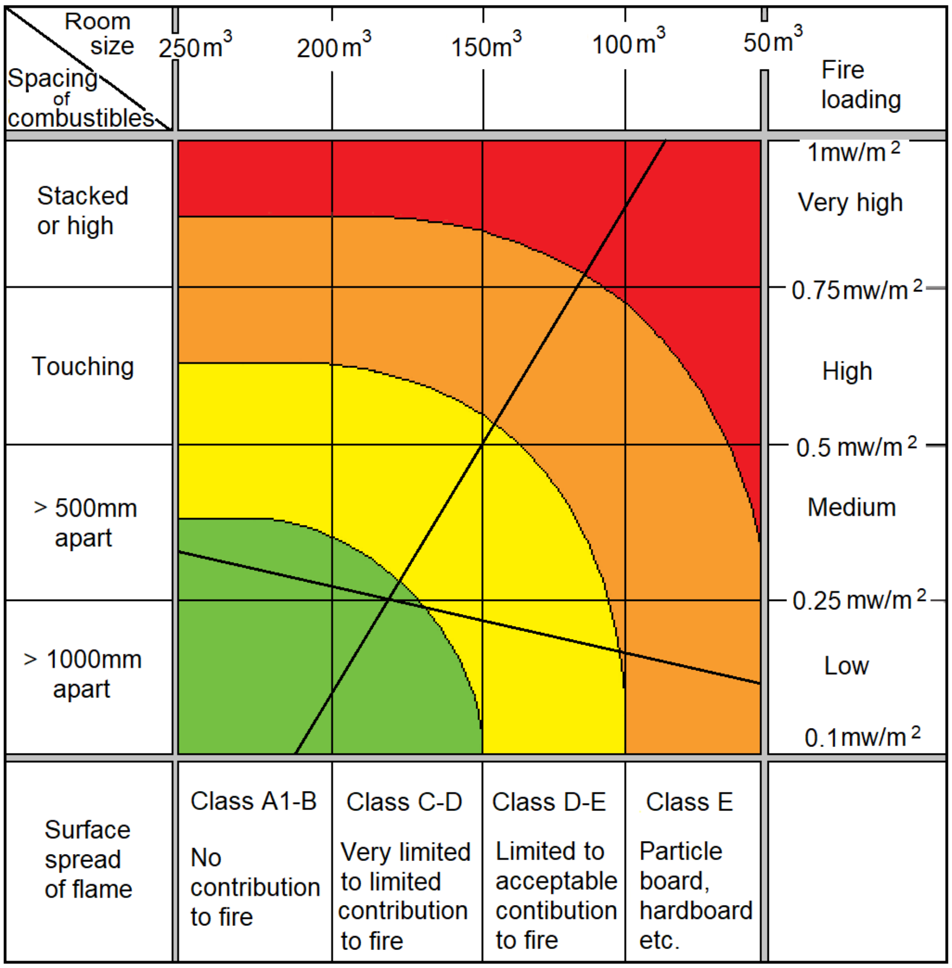
It was found that the larger the room, the lower the overall temperature of the hot smoke and gases produced by the fire, so doors are not exposed to the furnace type conditions of the British Standard test.

The results of the tests have given us a fire risk assessment tool, shown on the next page, so that historic doors can be individually assessed in their setting to determine what will be required to make them resistant to the passage of fire and smoke. See appendix 3.

Non fire rated door keeping fire at bay because of the lower temperature and pressure of an unventilated room

Non fire rated door and 4mm float glass remaining intact, even when fire burnt through the roof

The four most critical factors affecting fire growth are used on the axis of the graph; Room Size, Fuel Load, Surface Spread of Flame Rating, and How close together the packets of fuel are to each other. Vertical and Horizontal lines are draw on the graph and their intersection will determine the degree of upgrading the door will need.



(Green)	Plus (Yellow)	(Orange)	(Red)
Door to have self-closing device or room steward	Door to have self-closing device and cold smoke seals	Door to have self closer, intumescent strips cold smoke seals & 30 min burn through	Door may not afford 30 mins fire protection, consider reducing fire load or fit suppression

Diagram 16 Matrix for fire doors

This matrix has been used retrospectively, where fires have occurred and when real fires or testing has been undertaken to verify the results. These can be seen as examples in appendix 4

Appendix 1: Recommendations from Trenton Fire Engineering Report 2011

7.1 Although it is advised that further research is given to this topic with more modelling of differing situations (ventilation, room size, fire loads etc) so as to provide comfort in the results, the details in the following paragraphs would be considered as the proposed suppositions that may be proven.

- **Small rooms** (less than 50m^2 in floor area) will experience flashover quickly (if given suitable ventilation) and so no reduction in integrity performance of the associated fire doors should be made. If the furniture associated with rooms of this size can be determined as being "modern" and fire rated (soft furnishings) then flashover is likely to be delayed for 15 minutes and consequently the associated doors may have their performance reduced by 15 minutes –depending on other room fire loads.

- **Medium rooms** (50m^2 to 160m^2) would show a delay in the onset of flashover regardless of the furnishing type used and the evidence obtained would suggest that a delay of 10 minutes would be reasonable.

- **Large rooms** (above 160m^2) are likely to experience a further delay in flashover regardless of the furniture type, and so a greater reduction in the associated doorsets performance may potentially be given, up to 20 minutes.

7.2 The limitations of the above bullet points would be that the ceiling heights are no lower than 2.75m and that the fire load is considered "reasonable" for the room. Although "reasonable" is a fairly loose term, the application of a given weight per square meter would be equally difficult to police. Consequently, the term "reasonable" would have to be judged by an experienced fire engineer who should be engaged in any such determination in reduced fire performance.

7.3 Room fire detection should be provided to ensure that any alert is given at the earliest possible time and in all cases, it would be expected that not only the doorset is justified for the correct exposure to a BS 476 curve but also that the door leaf and frame condition are such that there is a good fit with adequate self-closing.

7.4 A professional fire engineer should be used to determine what is considered "reasonable" fire loads within a space, and then apply the findings of this report to reconsider actual fire growth against the room dimensions and ventilation. A determination can then be made as to any delay in fire performance of the relevant doorsets. Suitable door upgrades can then be obtained from relevant professionals based on the expected flashover conditions

7.5 It would be envisaged that further research is likely to not only confirm the above, but may also be used to prepare a matrix that would relate the onset of flashover to ventilation, room size and fire loads. From this point, a reduction in performance of a standard fire door may be given.

Appendix 2: Assessment of Fire Loads and Severity in Heritage Buildings September 2011 Simon Vickers

Abstract

This report presents the results of a series for fire load surveys carried out in five buildings under the jurisdiction of English Heritage and operated as museums and art galleries. Four of the buildings are from the Georgian architectural period and one from the early 20th Century. Five rooms in each of the buildings were surveyed.

The total fire loads, comprising both movable and immovable items, along with the room and ventilation dimensions were recorded. The fire load density was calculated for the individual rooms and the 80% fractile fire load density determined for each building, each architectural period (816MJm^2 for Georgian and 1045MJm^2 for early 20th Century) and for the whole sample (868MJm^2).

The individual room and 80% fractile fire load density for the whole sample was used to determine the design equivalent time of equivalent fire resistance for each room surveyed. This was analysed with regards to potential reduction in fire resistance requirements compared to the guidance presented in Approved Document B, Volume2, 2006 for compartmentation (60 minutes) and protection of means of escape (30 minutes). This has shown that there is a potential for reduction in the fire resistance of elements used for compartmentation. When considering fire protection for means of escape; where the individual room fire load density is applied three of the rooms had the potential to have the fire resistance rating reduced to 20 minutes, but when the 80% fractile fire load density is applied no rooms exhibited this potential.

CFAST zone models have been run for two of the surveyed rooms having the same ventilation are to floor area rations but significant variation in volume. These models have been run to assess the effect of are of ventilation (the number of windows breaking) increasing and the peak heat release rate of the medium growth rate t2 design fire. The output data has been analysed with regard to the upper layer temperature and the onset of flashover.

The results of these models show that, for these rooms flashover, taken as an upper layer temperature of 600ºC is reached fastest where one or two windows break. Where more break, the time will increase and flashover may no longer occur. The effect of peak heat release rate of the design fire decreases the time to flashover and increases the likely hood of flashover occurring as the area of ventilation increases.

These results indicate that there would be a potential for justifying a reduction in the fire resistance requirements for fire doors in the larger room but not in the smaller one.

Appendix 3 Testing of effect of room size on fire growth

There were six tests in total on three sizes of room, both ventilated and unventilated. Room sizes were double cubes to represent classical dimensions; 6m x 3m x 3 high, 8m x 4m x 4m high and 10m x 5 m x.5m high.

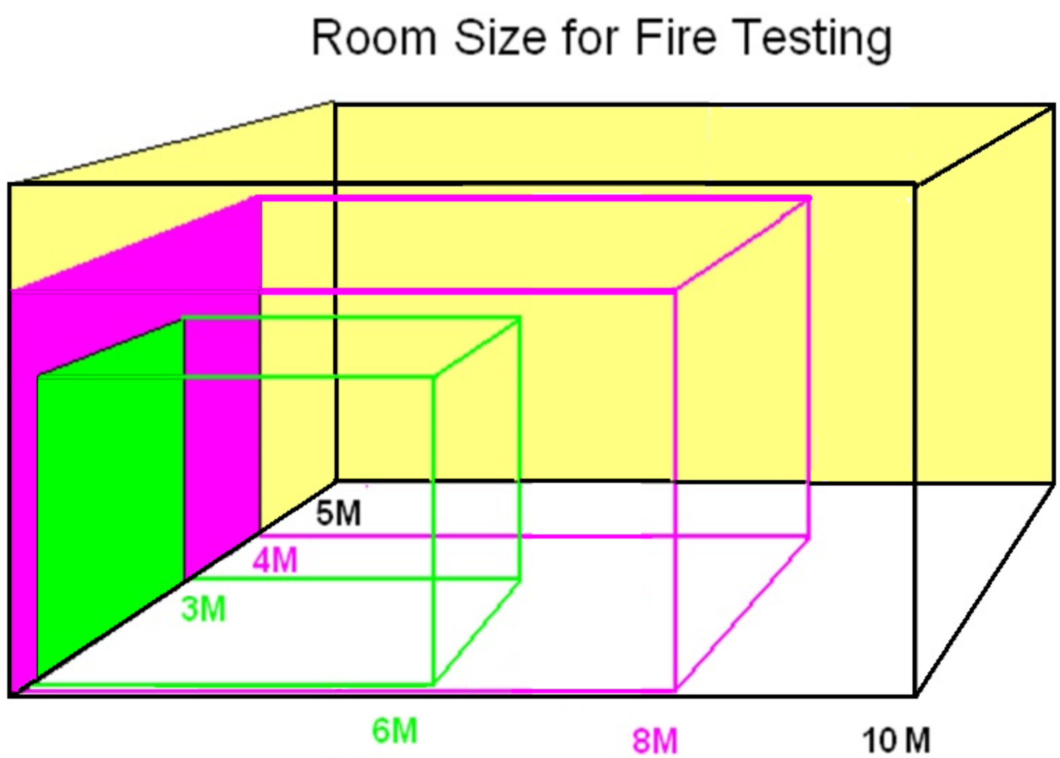


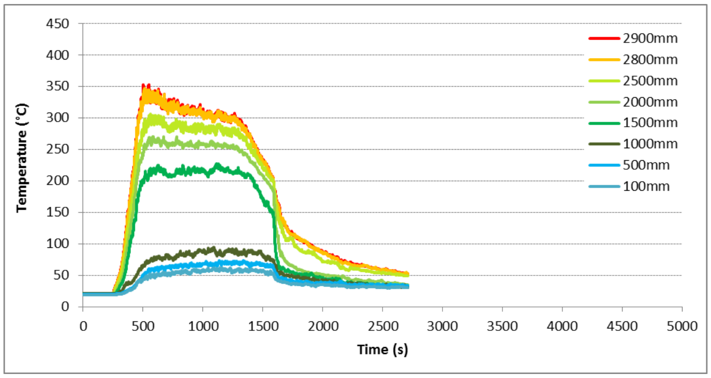
Diagram 17

Two doors were provided on the longest side and tests were carried out with them open to represent a ventilated fire and closed for an unventilated fire.

The fire load was provided by 42kg wooden cribs, each 1MW fire size.
The initial crib ignited was placed in the corner of the room to limit cooling air being entrained into the rising smoke plume.

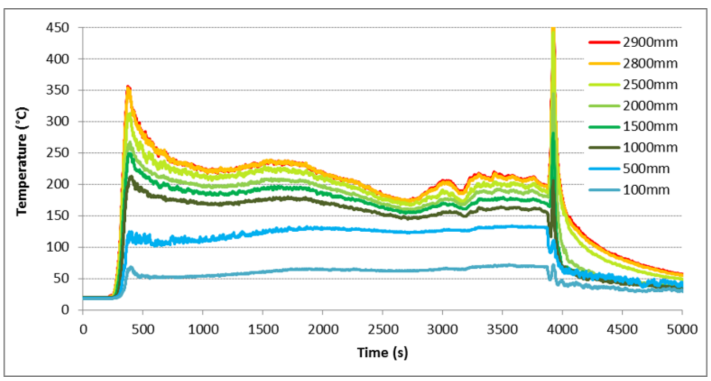
The first two tests were in the 6m x 3m x 3m room with two cribs. The second crib (target crib) was placed one metre away from the initial crib. As there was no fire spread, on subsequent tests the second cribs were put immediately adjacent to the target crib and draped with Egyptian cotton sheets to encourage fire spread due to radiation and direct flame impingement. The tests in the 8m x 4m x 4m had the target crib immediately adjacent to the initial crib and in the tests on the 10m x 5m x 5m two target cribs were placed immediately adjacent to the initial crib.

3m x 6m x 3m ventilated
Time temperature curve: 18



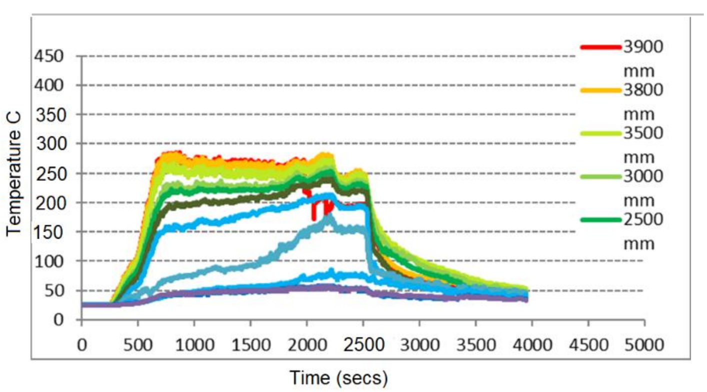
End of test with all fuel consumed, but no fire spread

3m x 6m x 3m unventilated
Time temperature curve: 19



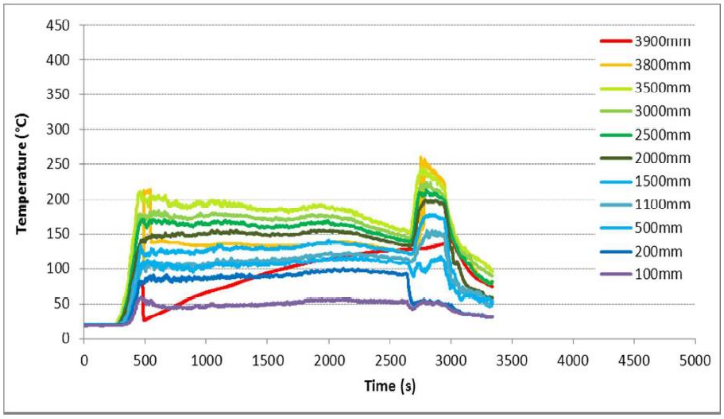
End of test with some fuel remaining

4m x 8m x 4m ventilated
Time temperature curve: 20



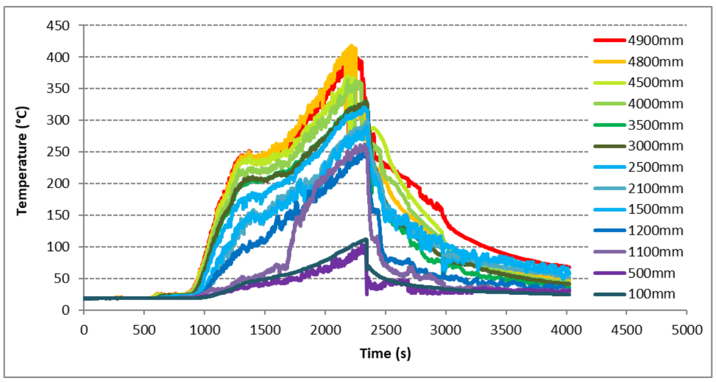
During test with some spread to covering of target crib

4m x 8m x 4m unventilated
Time temperature curve: 21



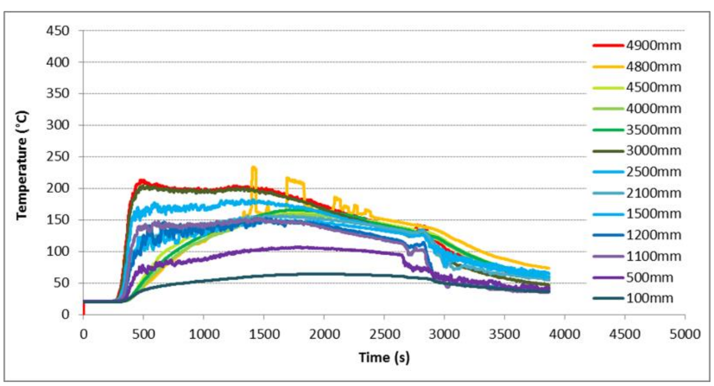
End of test with some fuel remaining

5m x 10m x 5m ventilated test
Time temperature curve: 22



End of test with all fuel consumed ; slight fire spread

5m x 10m x 5m unventilated test
Time temperature curve: 23



End of test with no fuel remaining and scorching of target cribs

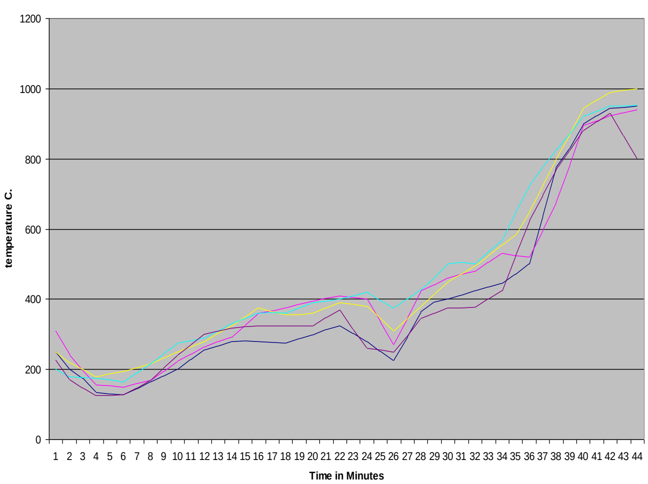
Appendix 4 Comparison of matrix examples

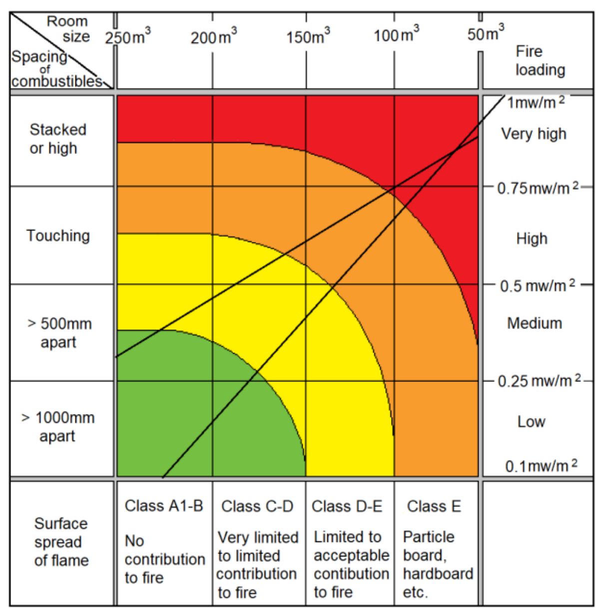
Chatham Row fire test

This fire test was undertaken in a Georgian terraced property to see if the lime plaster ceiling would give 30 minutes fire resistance. Temperature recording started at 15 minutes after ignition The time temperauture curve below shows that the fire was ventilation controlled until 5 minutes when the windows were opened slightly and again at 26 minutes when the windows were opened even further and the fire started to grow at the rate of a ventilated fire.The room was very modest sized at 14.53m^2 and 39.23m^3, which is below the smallest room size the matrix is designed for. The fire load was high at about 15MW or 0.99MW/m^2 to simulate non-fire retardant foam filled furniture. The intersection of the lines falls in the red section which recommends reducing the fire load to a level that an FD30 s door would provide sufficient protection. The results of the matrix are conservative because the door lasted for the 60 minute duration of the test.

Fig 25

Time temperature curve Chatham Row: 24



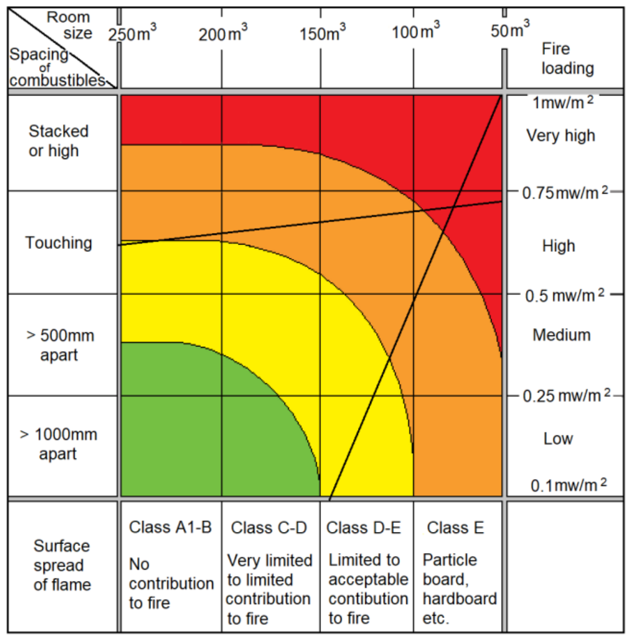


(green)	Plus (yellow)	(orange)	(red)
Door to have self-closing device or room steward	Door to have self-closing device and cold smoke seals	Door to have self closer, intumescent strips cold smoke seals & 30 min burn through	Door may not afford 30 mins fire protection, consider reducing fire load or fit suppression

Anonymous Fire

In this example the room was exactly 50m^2 and the fire loading consisted of seven floor to ceiling bookshelves filled with periodicals. The door was open during the fire, fully ventilating the room. The fire entered the roof above causing major damage.

Anonymous fire matrix Fig 26



Green	Yellow: Plus	Orange	Red
Door to have self-closing device or room steward	Door to have self-closing device and cold smoke seals	Door to have self closer, intumescent strips cold smoke seals & 30 min burn through	Door may not afford 30 mins fire protection, consider reducing fire load or fit suppression

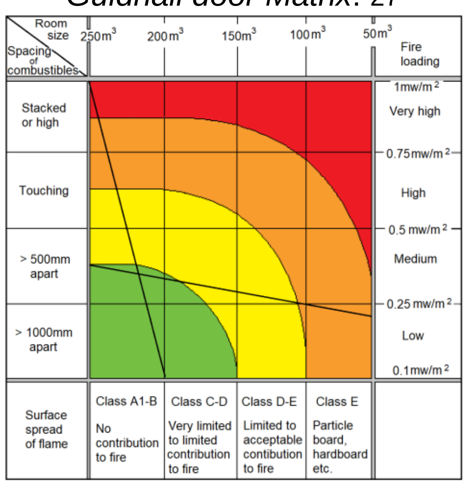
The Guildhall Bath

The doors in the Banqueting room of the Guildhall in Bath are historically important. The Guildhall is a Grade 1 listed building built by Thomas Baldwin in 1775. The double doors of four panels are made of Spanish Mahogany, which is no longer available because of extinction.

In the 1990s the doors were upgraded to provide 30 minutes fire resistance. The doors were then too heavy for the original hinges to support them and were rehung on piano hinges that are completely unsuitable. More appropriate replica hinges have since been fitted.

This damaging upgrade was unnecessary. The Banqueting room has a cubic capacity of $4212m^3$, floor area of $351m^2$ and a maximum fire loading of 300 chairs, a total of 60MW or / $0.17MW/m^2$. The chairs are never stacked in this room, but moved to an adjacent store room.

Guidhall door Matrix: 27

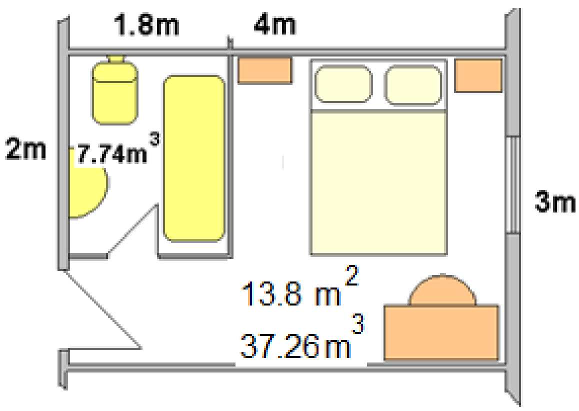


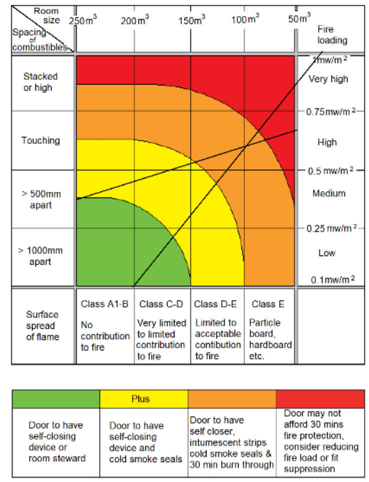
	Plus		
Door to have self-closing device or room steward	Door to have self-closing device and cold smoke seals	Door to have self closer, intumescent strips cold smoke seals & 30 min burn through	Door may not afford 30 mins fire protection, consider reducing fire load or fit suppression

Bedrooms

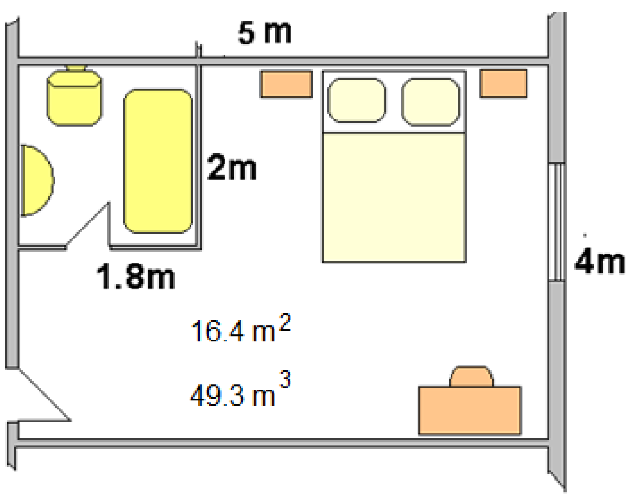
These two examples show the difference the size of the room makes, with the same furniture in both. The fire loading was calculated using the BRE document “Design fires for use in Fire Safety Engineering” by Christopher Mayfield and Danny Hopkin[7].

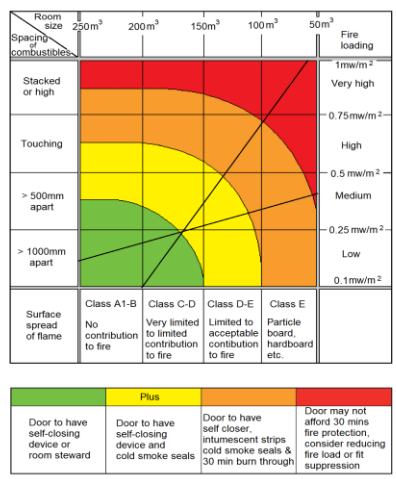
Small bedroom with door matrix: 28





Larger bedroom with door matrix: 29

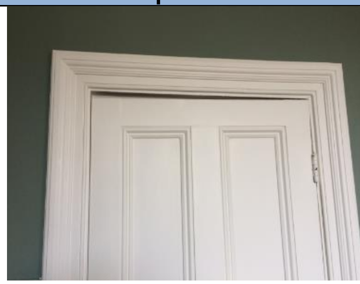
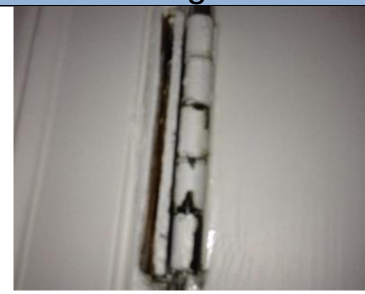




It is suggested that when the fire strategy drawings are compiled, fire doors that are the subject of the fire door matrix are coloured and numbered to match the text description.

The fire risk assessment should have a copy of the fire door matrix for each room with a photograph of the contents for audit purposes.

Fire door check: [30]

	Gaps	Seals	Hinges	Self Closers
Check for	 The door should fit squarely within its frame. The gaps at the top and both sides should be less than 4mm. Use a £1 coin to give a feel for scale, this is about 3mm thick. The gap under any door should be carefully considered, and the potential for installing threshold sealing should be one of the considerations.	 Look for smoke seals and intumescent strips around the top and edges of the door or frame. Check they're intact with no sign of damage. Check the smoke seals fill the gaps	 All hinges should be firmly fixed with no missing or broken screws. The hinges should be undamaged and not showing signs of excessive wear. If the door is not square in the frame push the latch edge to see if the top hinge is loose.	 Check the door closes firmly into the latch without sticking on the floor or the frame. Open the door about halfway and then let it go to make sure it self closes effectively. Check auto doors close on fire alarm activation
Why	The gaps need to be small enough for the intumescent to swell and fill them.	Intumescent strips expand when the temperature reaches about 150^0 sealing the door edge gaps and holding the door in position. Smoke seals stop cooler smoke escaping through the gaps, before the intumescent material reacts to heat.	Hinges worn so door dropped 	Groove in latch nib prevents door closing effectively 

Fire door check list with noted defects

Door no	Gaps more than 4mm, or 15mm at base	Intumescent & Smoke seals	Hinges	Closers and auto-closers	Defects and Remedial Action

Glossary of Terms

Architrave Timber member fixed to the face of the door frame to cover the gap between the door frame and the surrounding structure.

Bead/Beading Timber members, used to fix panels into position, often seen as a quadrant cross section with mitred ends.

Beads, Planted Beads which are fixed separately to the main door components, rather than being integral.

Defensively Fire and rescue service term to show that they are tackling a fire from outside as their dynamic risk assessment has determined that it is not safe for them to enter the building.

Doorset Door and frame with architrave and all the associated fittings. The whole assembly should be used for testing.

Fire Safety Engineering Application of scientific and engineering principles to the protection of people, property and the environment from fire.
(BS 7974 2019 Fire Safety Engineering)

Fire Safety Engineer A person with a fundamental knowledge of and experience with fire phenomena, and an understanding of how people, structures, and fire safety systems respond to fire.

Fire Safety Order The Regulatory Reform (Fire Safety) Order 2005 as amended. Statutory Instrument 2005 No. 1541

Forend That part of a mortice lock which is set into the face of the door edge

Intumescent Material which expands and/or chars under fire conditions and is used to stop the passage of smoke and hot gases, or to provide a longer burn-through time when applied to a surface..

Lock case/lockcase Main body of a lockset unit.

Mastic A form of adhesive sealant usually packaged in one or two part cartridges, applied using a cartridge gun.

Muntins Secondary inner vertical members fixed between the rails of a panelled door.

Neutral plane The height of the zone in a fire compartment where the temperature and pressure of the smoke layer is the same as ambient conditions.

Non-destructive surveys Survey methods which avoid disturbing the existing building fabric.

Offensively Fire and rescue service term to show that they are tackling a fire from inside the building as their dynamic risk assessment has determined that it is safe for them to do so.

Pascal Unit of pressure measurement (Newtons per square millimetre)

Rails Horizontal members forming the framing of a timber panel door.

Raised and Fielded Panels Door panels made popular in Georgian times that are thinner around the edges (the fielded part), allowing them to be fitted into rebated stiles and ledges and held in place with beads. Early doors had chamfered fields, but they became more formal and decorative with a lip up to the raised section.

Reveals, wood paneled decorative wood paneling covering the sides and top of a masonry doorway.

Shakes a form of splitting in timber where fibres separate along the grain owing to stresses developed in a standard tree, or in felling or in drying or converted timber.

Single swing/acting Denotes that a door leaf opens in one direction only.

Stiles Main outer vertical members forming the framing of a wooden door.

Strike Plate That part of a lockset which is fitted to the frame, into which the latch nib or dead bolt engage.

Unventilated Room. A room with closed doors and windows so that the fire does not receive enough oxygen to allow complete combustion.

Ventilated Room.
A room that has openings that allow fresh air to enter under the smoke layer (the neutral plane).

Index

Diagrams

Tables

References

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[5.] English Heritage Timber panelled doors and fire (updated version of limiting factors after further testing)

[6]. English Heritage Timber panelled doors and fire, prepared by International Fire Consultants, Warrington Fire
Research and Historic Royal Palaces

[7]. Design Fires for Use in Fire Safety Engineering, Christopher Mayfield, Danny Hopkin BRE Trust (5 July 2011)

Written by; Steve Emery CGFireE

Illustrations; All illustrations by Steve Emery

Photographs; "Four panel door provided good protection from a severe fire" on page 8 supplied by Cheshire Fire and Rescue Service, all other photographs by Steve Emery

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