IRONMONGERY, FIRE DOORS AND INTUMESCENT PROTECTION

GAI SPECIFIER'S GUIDE

The specifier's guide to the issues surrounding fire doors, appropriate hardware and the impact of intumescent protection on both.

Guild of Architectural Ironmongers

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GAI SPECIFIER'S GUIDE

Based on the RIBA Approved CPD of the same name, the specifier's guide to Ironmongery, Fire Doors and Intumescent Protection covers the issues surrounding fire doors, their appropriate hardware and the impact of intumescent on their effectiveness.

To ensure that your project meets the latest standards, regulation, legislation and best practice, it is strongly recommended that the ironmongery should be specified by a GAI Registered Professional such as a Registered Architectural Ironmonger (RegAI). All RegAI's have successfully completed the GAI Diploma in Scheduling qualification, and continue to maintain and update their knowledge through the GAI continuing professional development (CPD) programme. RegAI status is a clear demonstration of professional competence in matters which are critical to building safety, accessibility and security. Visit www.gai.org.uk/RegAI.

If you would like to receive a presentation of the CPD, this is available through GAI member companies. Please visit the GAI website (www.gai.org.uk) for more details.

CONTENTS

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1. THE IMPORTANCE OF FIRE DOORS

Internal side of fire door after fire

WHAT IS A FIRE DOOR?

- A fire door is a door with a fire-resistance rating which is used as part of a passive fire protection system to reduce the spread of fire and smoke between separate compartments of a structure and to enable safe egress.
- Fire doors are made from metal, timber or composite, and can be clad in other materials. Some have glazed vision panels.
- There might be one or two leaves in a frame. If there are two, they can be the same size or unequal widths.
- The door can open either one way (single action) or in both directions (double action).
- Fire doors must be installed to replicate their tested condition, and if you make any changes to them in any way, you are likely to negatively affect their fire performance, and certainly nullify any 3rd party certification or CE/UKCA mark.

Buildings are divided into "compartments" by fire-resisting walls, ceilings and floors. A fire door protects an opening in a fire wall and has the same level of fire resistance as the wall, e.g. 30 or 60 minutes.

When the fire door is closed, it can -

- stop any fire and smoke spreading.
- provide a safe and protected escape route while people evacuate the building.
- provide some protection for fire-fighters entering the building.
- Help limit the extent of damage to the building by containing any fire to the smallest area possible.

WHY DO WE NEED FIRE DOORS?

Their function is to:

- SAVE LIVES by protecting people from smoke inhalation.
- protect PROPERTY.

We expect them to be:

- Manufactured correctly.
- Installed properly.
- Maintained regularly.

If fire breaks out:

- We expect them to work.
- IN THE EVENT OF FIRE, fire spreads quickly and gives no respect to size, status or value of a building

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1. THE IMPORTANCE OF FIRE DOORS CONT'D

Fire door test

FIRE TEST EVIDENCE

- A fire door is a door which must have fire test evidence to prove that it is a fire door. For an ironmongery product to be used on a fire door it should have fire test evidence that it has been tested on a similar construction of fire door.
- The European standard for testing of fire doors is EN 1634 1.
- The British standard for testing of fire doors is BS 476 part 20-22 1987.
- Both EN 1634 1 and BS 476 standards are acceptable for fire door testing under Approved Document B and equivalents in UK and Ireland as well as Hong Kong.
- An example of an international test is UL10C. This is an American standard for testing of fire doors and is their equivalent to EN 1634 1, although there are distinct differences between the two including a hose stream test at the end of UL10C.
- Internationally, some or all of these test standards may be acceptable but local advice for each country must always be sought.

FIRE DOORS - FIVE MAIN RISKS

Manufacturing, supplying, specifying, installing or maintaining fire doors incorrectly can result in:

1. Danger for building users and possible loss of life.
2. Danger for emergency services responding to a fire.
3. Property and possessions will not be protected.
4. Risk to reputation.
5. Prosecution with a risk of fine or imprisonment.

Sashlock

Door closers

Hinges

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2. CORRECT FIRE DOOR HARDWARE

ESSENTIAL HARDWARE

Certain items of ironmongery (door hardware) are essential to a fire door's performance. They vary from door type to door type, but can include –

- Hinges (or pivots) to hang the door.
- Door closer to close the door.
- Lock or latch.

These 3 items are so critical that they must be CE or UKCA marked on any new-build according to the CPR.

OTHER HARDWARE

To complete the core essentials -

- Operating furniture (lever or pull handles) to open the door.
- Intumescent seals (sometimes with smoke seal).
- Signage (blue/white fire door sign to suit type of door).

All items must have proven fire performance to be considered for use on a fire door.

Automatic fire door keep clear sign

Fire door keep locked sign

Fire door keep shut sign

2. CORRECT FIRE DOOR HARDWARE CONT'D

FIRE SIGNAGE

There are three types of signs for fire doors identified as follows:

1. Doors which are self-closing, and used for passage of people.
2. Doors which are held open, or swing-free, but which revert to self-closing as soon as the fire alarm sounds.
3. Doors which are locked shut and only used occasionally (usually cleaners' cupboards, plant rooms, etc.).

INTUMESCENT SEALS

- Intumescent seals are vital to the timber or composite fire door. Hot gases will pour through the small gap between the door and the frame, as heated air around the fire expands and causes a pressure build-up.
- These seals are often supplied in a plastic or metal casing, sometimes with an integral smoke seal – wiper blade or brush type. They are fitted to the sides and top of the door or the frame.
- When heated by fire they expand to fill the space between the door and frame.
- Intumescent is often required to protect the ironmongery on a fire door, dependent on fire test evidence.

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3. FIRE TESTING

FIRE TEST EVIDENCE

When we take items to test it is always part of a complete doorset; It is very difficult to get a meaningful test result by testing items in isolation. The fire test shows how the various components of a doorset interact with each other when subjected to fire.

- Products are normally tested through to destruction.
- Fire tests follow a set time temperature curve.
- 3 modes of failure
  - 1) Integrity
  - 2) Insulation
  - 3) Gap gauge.
- Fire test report and assessment reports.

STANDARDS

The UK currently accepts fire tests carried out to either BS476 pt 20-22 1987 or BS-EN 1634-1.

Both of these standards use the same time/temperature curve and pass/fail criteria.

The image shows two furnaces both of which will accept a test sample at 3mts x 3mts so would comfortably take two full size doorsets. Both furnaces have the burners (gas fired) in the side wall with the only significant difference being the type of thermocouple used and this will depend on the standard you are testing to.

The BS476 test shown on the left has an exposed probe type thermocouple whereas the one on the right is set for EN1634-1 and has a thermocouple located under the insulated plate. Because the thermocouple is shielded the EN test is more aggressive in the first 5 minutes due to the burners being driven harder as the thermocouple does not register the heat as quickly.

The vast majority of manufacturers will test to the EN standard to give the widest scope for their products and this is why we have seen intumescent protection to ironmongery positions increase so dramatically. The size of the intumescent door edge seals have also increased as a result of this.

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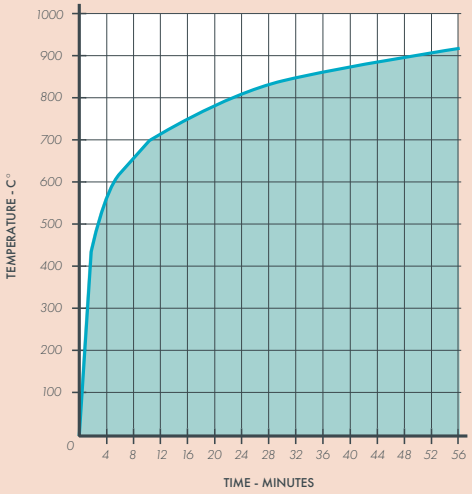
3. FIRE TESTING CONT'D

STANDARD TIME TEMPERATURE CURVE



STANDARD TIME TEMPERATURE CURVE

Regardless of whether it is a BS or EN test, both standards will follow a time/temperature curve as shown on this image.

As you can see there is a very rapid rise in temperature for the first 10 minutes of the test, we go from ambient to 600°C in the first 10 minutes. At this temperature the aluminium bodies to any surface mounted self closing mechanism will be getting close to melting so the intumescent door edge seals will be expanding & applying a positive sealing pressure to the door edge to try and hold the door shut & limit distortion. 700°C is reached at 15 minutes, 800-850°C at 30 minutes and 900 – 950°C is reached after 60 minutes. So as you can see there is a very rapid rise in the first 10 minutes and then it starts to level out.

As well as the rise in temperature a positive pressure is also applied inside the furnace to replicate the pressure build up and turbulence that would occur in a typical building fire. The pressure is controlled but will force hot gases to exploit any gaps that may open up.

The importance of correct timber density and type as well as correct specification and installation all become very clear when witnessing a fire test.

HOW FAILURE IS MEASURED

Testing to destruction - Integrity Failure:

- Total collapse or Hot gases passing through the specimen (Cotton pad test) .
- Gap Gauge Failure (6mm Test device can pass through)

Testing to destruction - Insulation failure:

Either the temperature on non fire side

- Exceeds 180°C above ambient in 1 spot

  OR

- Exceeds 140°C above ambient on average.

Mono ammonium phosphate

Hydrated sodium silicate

Intercalated graphite

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4. INTUMESCENT TYPES AND HOW THEY REACT

TYPES OF INTUMESCENTS

There are 3 main types of intumescent seals which can then be divided into two categories.

- Mono Ammonium Phosphate.
- Hydrated Sodium Silicate.
- Intercalated Graphite

The categories are either pressure generating or non-pressure generating. Typically you would use a pressure generating intumescent to try and prevent or slow down a timber door core from warping & to keep the door core within the door frame.

Hydrated Sodium Silicate (Palusol) & Intercalated Graphite are two of the most common types of pressure generating intumescent.

A non-pressure generating intumescent is typically used under a hinge blade or wrapped around the lockcase prior to it being fitted to the door core. This can act partly as a heat sink and when it expands it will not exhibit force between the lockcase and door core, maintaining the integrity of the lockcase housing.

Non – pressure generating intumescents are also widely used to protect around concealed door closers, where a large amount of the door core is cut away to house the closer. Mono ammonium phosphate would be categorised as non pressure generating.

MONO AMMONIUM PHOSPHATE

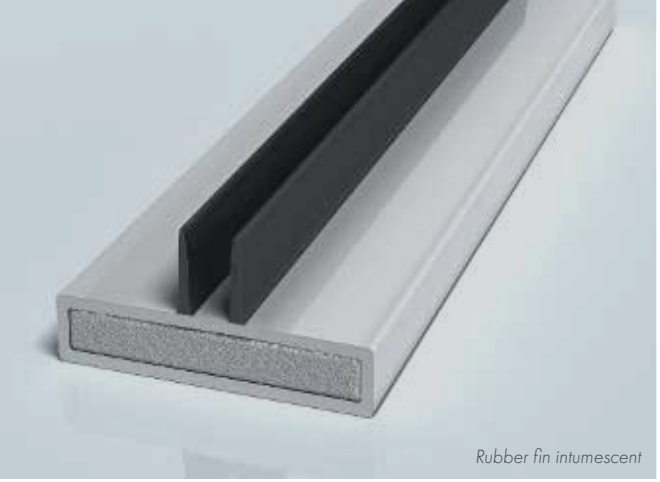
- Activates at around 180ºC.
- Virtually no pressure and it has some flexibility when expanded.
- Allows it to accommodate movement between components.
- Mainly used as multi-directional gap filler.

HYDRATED SODIUM SILICATE

- Activates between 100-120ºC
- Expansion in predominantly one direction.
- Forms rigid foam which also creates a substantial pressure.
- Once rigid it does not allow further movement but the pressure created within the gap helps in restraining movement and holding adjacent components together.

INTERCALATED GRAPHITE

- Activates between 180-200ºC.
- Multi direction expansion.
- High pressure forming.
- Gap filling properties with the ability to give secondary or tertiary expansion.
- Typical expansion is 15-20 times original height.



Rubber fin intumescent

Brush fin intumescent with varying layers

Different colours and fin options

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4. INTUMESCENT TYPES AND HOW THEY REACT CONT'D

DOOR EDGE INTUMESCENT SEALS

- Vast array of sizes available typically from 10 – 40mm wide x 2-14mm high.
- As a door edge seal it is often multi-functional and will commonly also provide cold smoke sealing and acoustic capabilities.
- Commonly used with timber or composite doors but also used for metal and all glass doors.
- Concealed intumescent systems with timber doors.
- Different seal size or intumescent types are required to cover the fire doors of varying width, height, configuration – one size does not fit all!
- Fire Test evidence is king, includes third party certification schemes.
- Systems available for joinery style 30 & 60 minute panel doors.

As you can see there is a diverse range of seals available. The images on the left show options for both Brush and Rubber fin smoke control. Single and multiple layers of intumescent can be incorporated within the plastic sleeving to provide a wide range of sealing options. More intumescent is not always the right approach to take though - always go back to the test evidence.

GRAPHITE BASED INTUMESCENT SEAL ONCE EXPANDED

The image on the right shows a graphite based intumescent seal which was located in a 15mm wide x 4mm deep rebate cut in the door frame on the centre line of the door.

Not only has the graphite packed itself tightly within the gap between the door leaf and frame, it has also expanded in width to end up flush with the face of the eroded door.

The door frame is shown above the hinge and below the hinge is 2 x timber stiles with the door core slab shown below. The fissures in the charred timber are not so severe each side of the hinge position as the Interdens hinge pad has reduced the erosion.

The image relates to a 30 minute BS EN 1634-1 fire test with the temperature recorded at 847°C at 30 minutes.

Graphite based intumescent seal once expanded

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5. INTUMESCENT SEALS FOR IRONMONGERY

Intumescent around hinge

Intumescent around lock

Graphite based intumescent

Graphite based intumescent after fire

MATERIALS USED

- Mono ammonium phosphate generally used for this application, however dependant on fire test evidence graphite based intumescents are now starting to appear on the market but be careful as not all graphite's are the same and fire test evidence should be followed.
- Intumescents used in ironmongery applications are working as heat sinks and gap fillers.
- Examples of door furniture requiring graphite-based systems would be letter plates and door viewers – certain concealed overhead closers.

GRAPHITE BASED SEAL PROTECTING CONCEALED CLOSER

In this case, a graphite based intumescent is used across the top of the closer extending to cover the complete cut out required for the control arm (above left).

The image on the left shows what has happened after the fire. You can see the graphite based intumescent packed between the door frame and door leaf to the side as well as extending across the top of the closer. In this case there is no intumescent protection around the body of the closer - machining the cut out as per the manufacturers detailed drawing/instruction sheet is critical. You can see how tight the closer body is to the cut out.

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MONO AMMONIUM PHOSPHATE AROUND HINGE & LOCKCASE

In the image above you will see the door frame to the top of the hinge and immediately below the hinge is the timber framing housing the door core.

It should be pointed out that these samples when removed from the furnace will have been hosed down and a lot of shrinkage takes place as the timber and surrounding items cool, however it still gives a good impression of how aggressive a fire test is.

You can see how the Interdens material has expanded out and flowed around the hinge. Also evident are the fissures in the timber around the fixing screws holding the hinge in place which will have been protected by the interdens flowing into the fissures but not exerting pressure in these voids.

The image on the top right shows the Interdens wrapped around the lockcase and as you will see this lockcase has the corner cut but it is not possible to cut the rebate in the door core to the same shape. In the event of a fire the timber will char and allow the fire into this void which will in effect allow the fire to accelerate by the thickness of the lock which could result in premature failure.

FIRE RATED LETTER PLATES

This image below shows the difference in expansion of four different types of Graphite.

To clarify, all the samples have been heated to 500°C using a muffle furnace & all samples started off at 10mm wide x 2mm thick x 50mm long.

The image shows a large variation between the samples but what it can't show is how well the expanded material binds together, in same instances the expanded material can be blown away.

All of these samples will be used in different applications and as you can see it is very much the case that all graphites are certainly not the same - it really shows the importance of checking to see what has been tested.

Four different types of graphite

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6. STANDARDS AND REGULATIONS

FIRE PERFORMANCE STANDARDS

There are two fire performance standards that are accepted for use within the UK:

- BS 476 part 20-22 1987: - This is the current British Test Standard.
- EN 1634-1 2014+A1:2018: - This is the current European Test Standard.

The above test standards will provide the Integrity (E) & Insulation (I) performance for the sample tested. The test Report provides the backbone for 3rd Party Certification Scheme requirements and is also used as the starting point for Global Assessments etc. Both tests follow the same time temperature curve, the main difference is the type of thermocouple used to record the furnace temperature.

SMOKE LEAKAGE STANDARDS

The current standards applicable to the UK are as follows: -

- BS 476 part 31:1 & EN 1634-3: 2004.

Although these are often described as smoke seals, the standard actual tests for the amount of air leakage from the perimeter of the sample whilst being subjected to both negative and positive pressures. The results are expressed at 25 pascals above and below atmospheric pressure. Third Party Certification schemes will also introduce cycling testing to evaluate the durability of the seal in the working environment, typically the seals will undergo 100,000 opening and closing actions and are then retested to establish the effect of wear and tear on the smoke seals performance.

ACOUSTIC PERFORMANCE

Increasingly the Intumescent Seal is also required to contribute towards the overall Acoustic rating of the doorset.

This is known as the Measurement of Airborne Sound and the applicable standard used in the UK is BS EN ISO 10140-2.

When meeting the acoustic performance in Schools Building Bulletin 93 (BB93) should be consulted as this lays out minimum performance standards for the acoustics of school buildings.

Approved document E in support of the Building Regulations gives the following guidance: The normal way of satisfying Requirement E4 will be to meet the values for sound insulation, reverberation time and internal ambient noise which are given in section 1 of Building Bulletin 93 'The Acoustic Design of Schools.

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6. STANDARDS AND REGULATIONS CONT'D

EN 15804:2012 ENVIRONMENTAL DECLARATIONS

Ironmongery for fire and escape doors can have their environmental impact communicated in a standardised manner through Environmental Product Declarations or EPDs.

These are not mandatory but certain manufacturers do provide this information.

Declarations include information on the environmental impact of: raw material acquisition, energy use and efficiency, content of materials and chemical substances, emissions to air, soil and water and waste generation. Product and company information is also included.

It has been developed to provide information from life cycle assessments (LCA) and is issued by an independent program Operator.

The standard which relates to EPD is BS EN 15804:2012. The standard which relates specifically to hardware in respect of EPDs is BS EN 17610:2022.

BS 8300:2 ACCESSIBILITY

The specification of ironmongery for fire doors can be impacted by the use of intumescent seals.

BS 8300 2 the standard for accessibility states that "The choice of controlled door closing devices should take account of... the resistances from edge seals, hinge friction, latch resistance and differential air pressure.

It also states that "Where smoke seals are required, e.g. to protect refuges and lift lobbies, the force required to open the door can be reduced by installing an angle seal as an independent item in the door frame."

APPROVED DOCUMENT B : FIRE SAFETY

Approved Document B in England covers fire safety matters within and around buildings.

In July 2018, the UK Government announced it was to launch a full-scale review of Approved Document B to clarify and reduce the complexity of fire safety guidance.

A new clarified version of Approved Document B was published in July 2019 and remained in two volumes:

- Volume 1: Dwellings.
- Volume 2: Buildings other than dwellings,

APPROVED DOCUMENTS – CHANGES AHEAD

In December 2018, the Government enacted changes to The Building Regulations 2018, to restrict the use of combustible materials over 18m which become part of an "external wall", or "specified attachment" of a "relevant building", alongside amendments to Approved Document guidance and Regulation 7.

The Department for Levelling Up, Housing and Communities (DLUHC) are undertaking a wholesale technical review of Approved Document Part B guidance

A series of guidance papers on fire safety can be accessed through RIBA website.

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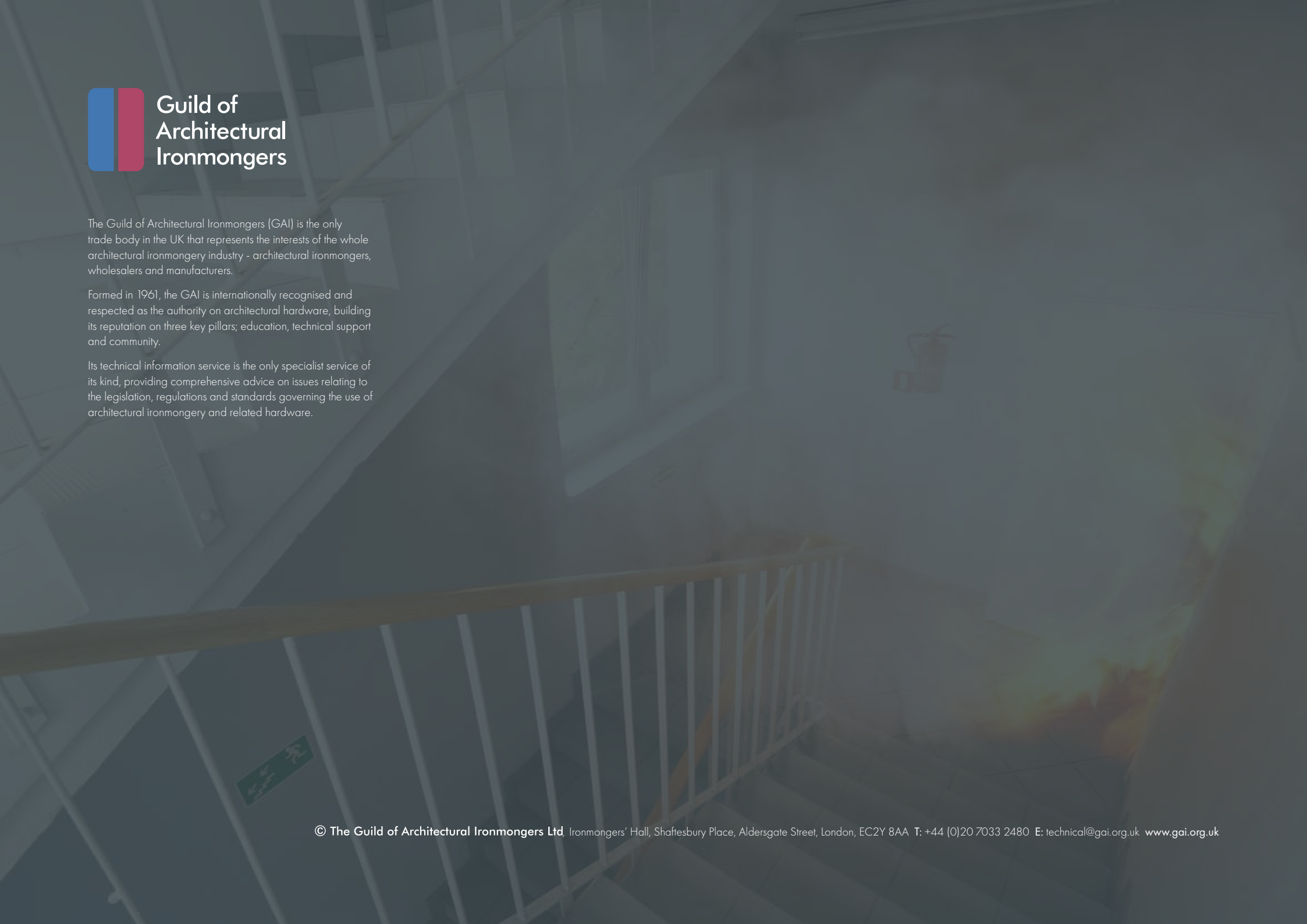
7. FURTHER HELP AND ADVICE

RESOURCES

- **GAI website**
  www.gai.org.uk
- **GAI Specifiers Guides**
  www.gai.org.uk/specifiers
- **RIBA Approved CPDs**
  www.gai.org.uk/GAI/GAI/Knowledge/CPD-Presentations.aspx?hkey=0bea81c0-7372-47a5-85d6798d9aae0794
- **Code of Practice: Hardware for fire and escape doors**
  Published by DHF/GAI
  www.gai.org.uk
- **RIBA Guidance on fire safety**
  www.architecture.com



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The Guild of Architectural Ironmongers (GAI) is the only trade body in the UK that represents the interests of the whole architectural ironmongery industry - architectural ironmongers, wholesalers and manufacturers.

Formed in 1961, the GAI is internationally recognised and respected as the authority on architectural hardware, building its reputation on three key pillars; education, technical support and community.

Its technical information service is the only specialist service of its kind, providing comprehensive advice on issues relating to the legislation, regulations and standards governing the use of architectural ironmongery and related hardware.

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