Fireplaces, Flues and Chimneys

SPAB Technical Advice Note

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The fireplace and chimney are important historic elements of many old buildings. These features speak volumes as to how such buildings have evolved. Balancing the historical integrity of a fireplace and chimney while maintaining their functionality is often a challenge. This Technical Advice Note covers the diagnosis of common defects and offers practical remedies. Additionally, it provides information on fire risk and safety, as well as advice on alterations to fireplaces and energy efficiency improvements. The focus is primarily on fireplaces, flues and chimneys in domestic buildings.

Cover image: Prominent chimney stacks contributing to the architectural significance of medieval terraced houses in Vicars' Close, Wells, Somerset.
Photo: © Douglas D Kent

1 Introduction

A fireplace is linked to a flue that is encased by the chimney (see figure 1). This arrangement is designed to remove the products of combustion safely from the internal to the external environment. It also creates an airflow through a wood or coal firebed to help provide sufficient oxygen for efficient combustion. But chimneys are frequently dramatic features in their own right, which contribute to the architectural significance of historic buildings (see cover image). They may, whether originally intended or not, also fulfil structural functions within a building.

Chimneys work because hot air rises. Any intervention to the arrangement of a fireplace, flue or chimney may affect the efficiency of the burn and draw of the fire. Repairing defects in chimney masonry and making flues work more efficiently is a common task in the maintenance of old buildings. Ensuring fireplaces, flues and chimneys work safely without putting occupants or buildings at risk is paramount. Even when a fireplace becomes redundant certain issues must be addressed before decommissioning the flue, and ongoing maintenance will be required.

This Technical Advice Note considers next the history and construction of fireplaces, flues and chimneys (section 2). A sound understanding of these aspects will help ensure a proper appreciation of the significance of such features. Good information on their history and construction also provides information essential for the analysis of any defects and for effective repair. The methods and materials for repair are described later, along with ways of minimising fire risk, improving the energy efficiency of redundant or active flues, and alterations (sections 3 to 11). Technical terms used in this guidance are defined in our online glossary.[1]

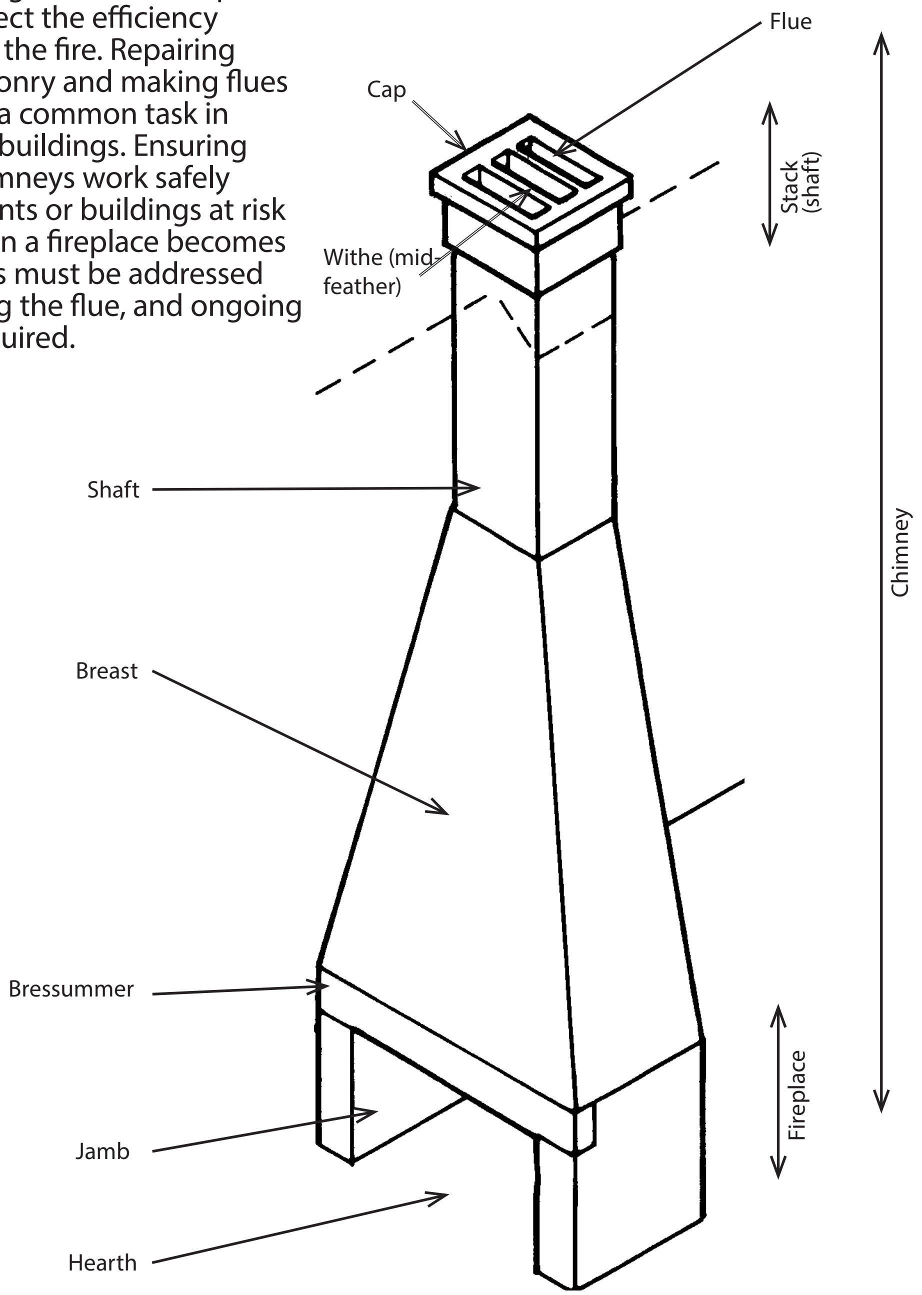

Figure 1: Parts of a chimney.

Illustration: Douglas D Kent

2 History and construction

2.1 Medieval

Fires have always provided essential sources of heat and light and provision for cooking. Most medieval houses were simple timber-framed structures with open hearths. These were typically circular or octagonal and of stone or tile, surrounded by a stone kerb. Smoke from the fire would hang in the air, diffuse upwards and escape through unglazed windows in the side walls or through louvres,[2] or seep through the thatch. The open trusses of the roof structure became heavily soot-encrusted. The smoke-blackened underside of the thatch, resulting from the deposition and infiltration of products of combustion is, like the soot on roof timbers, significant archaeological evidence: it should be retained. There are many examples of ground floor halls with open hearths (see figure 2).[3]

Open hearths were kept alight continuously with slow-burning wood, such as oak or elm, creating rising columns of hot air and smoke. In poorer houses, gorse, peat or even cow dung might be burned, producing very dark and smoky conditions. Timber screens within rooms were often used to shield the hearth (and occupants) from the rush of air through window and door openings. In higher status households, food was cooked in detached kitchens at the rear, due to fire risk, and examples still survive.[4]

Chimneys were sometimes used as an alternative to open hearths, particularly in more prestigious buildings. The term 'chimney' or *cheminée*, *caminus* etc was used to denote the fireplace, hearth, mantle, flue and chimney or any of its parts.[5] Early hearths might be made of a single large stone, several stones, or from tiles or bricks. In some areas, the backs of fires or reredoses were made of tiles or bricks.

Where chimneys existed in more modest buildings, they were often built of lightweight, and flammable materials. Examples of surviving medieval flues, of wicker or 'raddle' and daub, are documented in cottages in the Welsh Marches and Carmarthenshire in the 1930s.[6] Due to frequent outbreaks of fire, ordinances were passed in the City of London in the 14th century forbidding any reredos where a fire was made for preparing bread or ale, or cooking meat, being placed near partition walls of laths or boards. Chimneys were no longer to be of wood but of stone, tiles or plaster.

Stone construction was generally the preserve of the social elite up to the early 14th century and this sometimes allowed the inclusion of a corbelled stone hood and chimney (see figure 3).[7] The narrowness of some fireplaces suggests that wood must have been piled up high on end. From the mid-14th century, fireplaces with stone surrounds gradually replaced stone hoods in larger stone buildings. Many examples of 15th-century stone fireplaces have some variation of a four-centred arch, with either arched or square heads and decorated spandrels.[8]

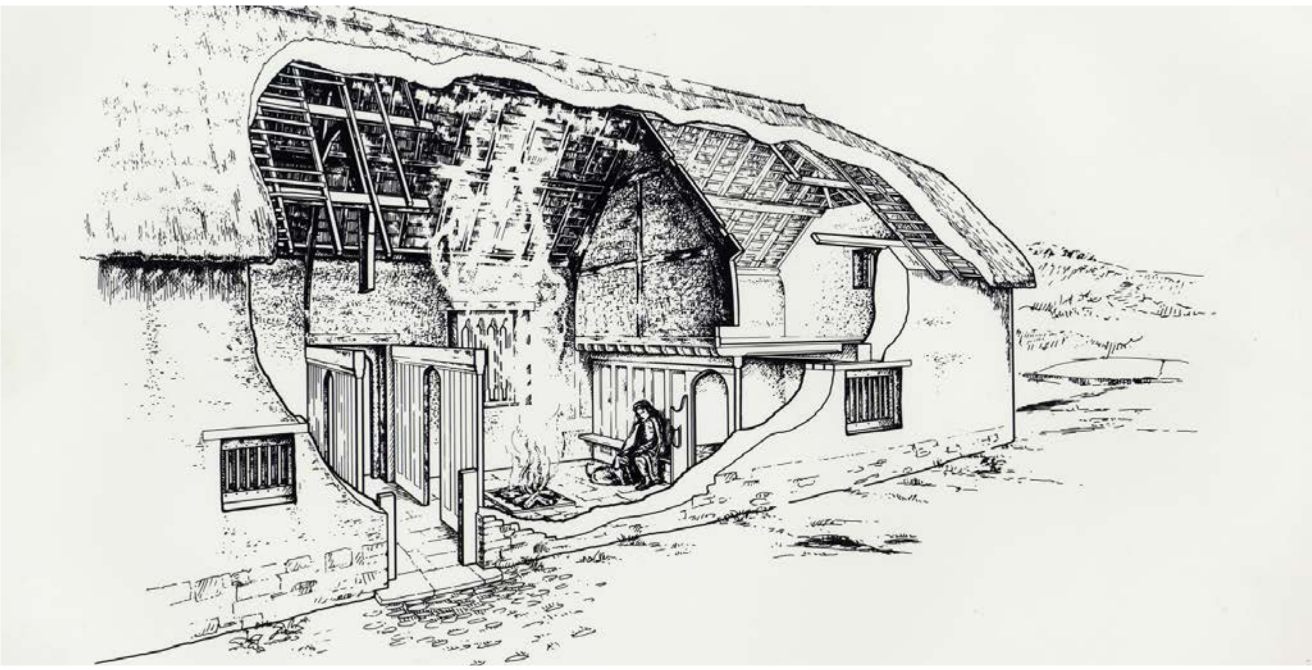

Figure 2: Medieval hall house with open hearth.

Illustration: © Rupert Ford

Figure 3: Corbelled stone hood, c1315. Gatehouse, Ham Court, Bampton, Oxfordshire.
Photo: Sally Stradling, with thanks to Matthew Rice

Early chimney shafts were cylindrical and open at the top,[9] later becoming octagonal or square with stone caps, first crenellated and then moulded. Embattled caps, derived from French examples of crowns of iron spikes, were intended to break up the cross-currents of wind.[10] By the 14th and 15th centuries, the lantern form of chimney cap was popular, often traceried or with triplets of lancets (see figure 4).[11] The vertical openings at the sides were probably intended to prevent downdraughts and keep out rain. Stacks had gutters and weatherings to prevent rainwater running down and seeping under the tiles.

Figure 4: Flue with triplets of lancets, c1260. The Checker, Abingdon Abbey,
Photo: Sally Stradling, with thanks to Friends of Abingdon Abbey

2.2 Sixteenth and seventeenth centuries

By the 16th century, greater demand for comfort and privacy meant draughty, smoky open halls started to be floored over and fireplaces with walled chimneys were inserted to control the smoke. Simultaneously, private rooms were created above the hall and staircases introduced.

In larger houses, great chambers began to be located over parlours at the 'high end' and offered families rooms separate from servants. More widespread use of chimneys allowed kitchens to become integrated within the main house, rather than being detached structures, as fire risks lessened. Kitchen fireplaces tended to be very wide so that long logs could be laid on iron fire dogs with meat radial-roasted on long spits, turned at first by hand and then by weights and pulleys (see figure 5). Similarly, between about 1550 and 1700 cottages and farmhouses generally evolved from open halls to floored two-storey houses (see figure 6).

Figure 5: Kitchen fireplace c1600s. Chastleton House, Oxfordshire. Note the width of the fireplace and insertion of later cast iron range and copper.
Photo: Chris Lacey © National Trust Images

Figure 6: Kitchen, c1300-1900s. Manor Farm, Cogges, Oxfordshire. Open hall with inserted floor, lateral chimney stack with wide fireplace, later inserted cooking range and side cupboards. Note the spit rack above the fireplace.
Photo: © Heather Horner, with thanks to Cogges Heritage Trust

The transition from open fires to chimneys was accomplished in several stages. These included the use of a central hearth with cooking pots suspended on chains in front of a stone reredos with a partition behind; a smoke bay, where part of the hall was floored over and part left open as a route for smoke to escape; a smoke hood which helped channel the smoke away from the room; and an external or internal chimney.

The smoke bay or smoke hood was a wooden-framed structure protected with a covering of plaster (which was often earth-based) to protect the structural timbers. Often chimneys were later built within both structures.

In the case of the smoke bay, this was sealed off from the upper part of the rest of the house to allow the smoke to escape.

The smoke hood was supported on the mantel beam of a fireplace and smoke was funnelled vertically upwards to an outlet on the roof. While constructed in timber and lath and plaster, smoke hoods presented considerable fire hazards. Cowls of overlapping boards, as in the north of England, were an alternative form. The smoke hood in cottages and farmhouses was translated into stone.[12] In poorer cottages, wicker barrels with the ends knocked out were sometimes used to form the outlet from the chimney through the thatch.

In many areas, use of brick became more common or fashionable from the Tudor period onwards and, in royal palaces and the houses of the gentry, elaborate chimney shafts were produced to striking effect. Chimneys became much plainer during the Elizabethan period.[13] The 17th century saw a fashion for setting the chimney anglewise to the base[14] and grouping several flues together into a massive stack.

In 1587, social commentator William Harrison wrote of 'the multitude of chimneys lately erected'.[15] For most of the population, brick or stone chimney stacks were added to existing houses, either in the cross-passage or on the exterior. At first, separate stacks were built for each flue, but gradually chimney stacks became grouped together in a solid block and later linked only at the base and cap, allowing air to pass through, thereby preventing downdraughts from the wind hitting a solid block of masonry.

7(a) 7(b)

Figure 7: Inglenook fireplaces: (**a**) South Oxfordshire, c1600s, with seat alcoves either side for enjoying the warmth of the fire. The original flagstones under the grate would have been flush with the floor to allow debris to be swept into the hearth. **(b)** Kitchen fireplace, c1550, with pot crane, bread oven and cast iron fireback. Pendean, Weald and Downland Living Museum, West Sussex.
Photos: Marianne Suhr **(a)** and Sally Stradling, with thanks to Weald and Downland Living Museum **(b)**

The 'inglenook' fireplace in the now combined hall/kitchen became widespread, superseding the open hearth in vernacular cottages and farmhouses of 16th- and 17th-century date (see figure 7). This enclosed the fire on three sides and provided the opportunity for seats to warm occupants. There was perhaps the opening to a bread oven (without flue) at one side and salt cupboards, or a ham or bacon curing chamber, on the other. Cooking pots were suspended from iron hooks and pans supported on iron grates over the embers. The hearth was flush with the rest of the floor to allow dirt from the room to be swept into it. The parlour became heated by a separate walled fireplace. Back kitchens/service rooms came into being for the separation of tasks such as baking, brewing and washing clothes (see figure 8).[16]

In larger houses, arched stone or brick fireplaces frequently became principal architectural features in the 16th and 17th centuries. Common are four-centred 'Tudor' arches, sometimes with decorated spandrels, moulded jambs and a moulded mantel shelf. Lesser buildings are more likely to have simple timber lintels of oak or elm, sometimes with chamfer stops, on stone or brick jambs. In the early 17th century, elaborate stone, plaster or timber overmantels were used to display Renaissance fashions imported by craftsmen from Italy, Flanders and Germany and interpreted by local craftsmen (see figure 9).

The period after the Restoration of 1660 marked a watershed in the development of domestic architecture, with the introduction of classical proportions and detailing in chimney design. This further emphasised the chimney piece around the fireplace opening as the focal point of the room. Overmantel mirrors and shelves for the display of china were sometimes incorporated, though before the 19th century many fireplaces simply had a moulded surround with no shelf or space for display of objects. Corner fireplaces were typical of this period. They may have been influenced by court fashion after Charles II returned from exile in France, the Spanish Netherlands and Dutch Republic; but equally plausible is that they required less building materials than a chimney stack which was square on plan. Typical for houses of the late 17th and early 18th century which aimed at some architectural pretensions were fireplaces with a heavy bolection moulding around the opening and a deep moulded cornice above (see figure 10). Some fireplaces were lined with plaster and painted with geometric patterns. In other cases, decorative cast iron firebacks started to be used.

Building Acts came into force after the Great Fire of London, including the Acts of 1667, 1708 and 1774, which aimed to control the rebuilding of houses to ensure that new buildings were as fire-resistant as possible. Some of the rules dictated the dimensions of chimneys and their position relative to party walls.

Figure 8: 'Back kitchen', c1600s-1900s. Manor Farm, Cogges, Oxfordshire. Main range in centre, bread oven to left, copper for washing clothes to right.
Photo: © Heather Horner, with thanks to Cogges Heritage Trust

Figure 9: Renaissance details, early 17th century. Abingdon, Oxfordshire. Photo: Sally Stradling

2.3 Eighteenth century

By the 18th century, the influence of architect and pattern book was widespread; symmetry became fashionable in the design of new houses and fireplaces, influenced by classical imagery brought back from the Grand Tour.[17] The native, irregular Gothic style was superseded by the building conventions of Italy. More fashionable houses had central entrances and gable-end chimneys, and were either of single-room depth or 'double-pile', ie two rooms deep. Existing houses were frequently modernised with a brick, stone or rendered elevation - often lined out to imitate stone; old chimneys and fireplaces were updated but rarely demolished.

The fireplace or 'chimney piece' of larger houses comprised a projecting lintel (entablature) supported by columns, pilasters or consoles, and from the 1720s onwards usually carried a large overmantel. Dutch, tin-glazed 'Delft' tiles - white with surface decoration of blue or brown - were among those used in the 18th century for fireplace surrounds or recesses. From the 1750s, English factories produced imitations and, by the end of the century, the English tile-making industry had revived.

Figure 10: Detail, fireplace with bolection moulding, c1700s. Steventon, Oxfordshire. Photo: Sally Stradling

Early 18th-century fireplace designs were often heavy and ornate with swags, scrolls, masks and shells – the latter a signature motif of designer William Kent. Materials included stone, marble, wood or scagliola. Later in the century and under the influence of Robert Adam, lighter neoclassical designs appeared with motifs such as urns, swags and figures from classical mythology (see figure 11).

Throughout the 18th century, the fielded panel was popular in simpler farmhouses and townhouses for adorning the chimney breast - which included the fire surround, overmantel and cornice entablature. Decoration of the overmantel might include a panel painting, usually a landscape.

By the late 18th century it was recognised that fireplaces were too large to function efficiently and householders saw the need for more precisely controlled grates and smaller fireplace openings. The change was also the product of developments in transportation, which made coal more widely available. The invention of the Rumford grate in 1796 transformed attitudes to the arrangement of fireplaces and their workings. (See sections 2.6 and 5.2.)

2.4 Nineteenth century

By the 19th century, problems with smoking fireplaces and the quest for improvements in the draw led to fireplaces and their openings decreasing in size. Standard elements comprised a fire surround, cast iron grate and ceramic tiles in reveals. An alternative was the 'Coade stone' chimney piece made from Eleanor Coade's highly durable ceramic.
The most common form of fire surround was

Figure 11: Fireplace, 1750s. Nuneham Park, Oxfordshire. Photo: Sally Stradling, with thanks to Global Retreat Centre

a simple arrangement of flat jambs and lintel supporting a mantel shelf. In the early 19th century, typical Regency fireplaces were plain and of simple rectilinear form, with two small paterae inserted in the top corners or recessed reeding at the sides. The design was produced in timber, plaster, stone and marble, and could be enriched with a variety of mouldings and ornate brackets of acanthus leaves or garlands of flowers.

Foundries, such as those of the Carron Company and at Coalbrookdale, mass-produced cast iron fire surrounds, sometimes with integral grates (see figure 12). Timber and plaster surrounds tended to be painted, and cast iron painted or blackleaded. A hierarchy of materials and decoration evolved for public and private rooms with greatest expense being lavished on the most frequented sitting rooms, while family bedrooms and attic rooms were provided with plain fireplaces, commonly of painted timber or cast iron.

With the 'battle of the styles', a multitude of revival chimneys and associated fireplaces were produced during the 19th century from neo-Gothic, Elizabethan, early Renaissance revival to the Queen Anne style of Norman Shaw, W E Nesfield and others (see figure 13).

Figure 12: Mass-produced fireplace, c1875. Warwick. Photo: Sally Stradling

Factories, such as Minton, Hollis & Co, produced medieval-style stamped tiles.

2.5 Twentieth century

Change was inevitable with the introduction of gas lighting and electricity from late Victorian times. Early on the Arts and Crafts movement drew upon a vernacular past and the inglenook enjoyed a resurgence under architects such as Sir Edwin Lutyens and C F A Voysey. The distinctive new style of the Art Nouveau movement superseded this, a main proponent being Charles Rennie Mackintosh. After the First World War, however, a simpler style evolved in brick or ceramic. As society changed, and with lack of labour for stoking large numbers of fires in larger houses, new methods of heating - including oil central heating, gas and electric fires - replaced open fires as the main heat source.

2.6 Grates

Timber for fuel was increasingly scarce by the 16th century and the burning of bituminous or 'sea' coal (referring to its transport by barge) occurred from the 17th century onwards, becoming general in urban homes in the 18th century. As coal continued to be burnt in larger quantities at all levels of society, use of this fuel led to developments in the shape and construction of the fire bed container.

Grates evolved from the hearth with fire dogs (or andirons) holding burning logs to the iron basket supported on andirons and finally, in 1750, to the dog grate combining all earlier components into one. By the mid-18th century, this was simplified into the coal burning 'hob'

Figure 13: Tudor revival fireplace, late 19th century. Randolph Hotel, Oxford. Photo: Sally Stradling

grate with the fire raised over the hearth and fenders to protect against flying embers (see figure 14). These were manufactured in great numbers by the Carron Company and Coalbrookdale foundries.

The hob grate, unlike its freestanding predecessors, was set into the fireplace and had horizontal bars to hold the burning coal in place. Flat metal plates were located on either side on which pans and kettles could be heated. In practice, very little heat was reflected out into the room and the wide fireplace opening made it difficult to control draughts or prevent smoking. Numerous experiments and ideas for the control of noxious smoke came and went from the 17th century onwards. Many books contained advice on the subject.[18]

The most important contribution, however, was made by Benjamin Thompson, an American adventurer and amateur engineer who was awarded the title of Count Rumford by the Elector of Bavaria in 1791. On a visit to England, Rumford observed the primitive condition of fireplaces, in which most heat went up the chimney and the smoke into the room. This resulted in his essay 'Of Chimney Fire-Places' of 1796, which comprised a series of recommendations. Rapid change resulted, with many existing fireplaces becoming 'Rumfordised' and new cast iron Rumford grates being manufactured.

Despite the clear advantages of the Rumford grate, the Victorians were swayed by the financial benefits of mass-produced foundry cast iron fireplaces which required minimal labour in their installation. Smoke continued to be a real problem in towns and cities and, despite the Public Health Act of 1875, was not helped until the invention of the 'Economiser' by Dr Pridgin Teal. This was a box with an adjustable air shutter at the front which was formed under the grate.

2.7 Chimney pots

The earliest clay chimney pots were developed from the 12th or 13th century.[19] The clay chimney pot was introduced in quantity in the 18th century as a way of reducing downdraught by increasing the height of the existing stack. It is thought to have been evolved from the 'truncated pyramids' devised by Nicolas Gauger in 1713 to improve the draw of his 'ventilating fireplace', described in his treatise, *La Mécanique du Feu* (*The Mechanism of Fire*) (see figure 15). Pots could be as high as 2.3 m. They became popular during the reign of George III (1760-1820) and were often sunk into brick shafts so they remained hidden from ground level.[20]

Chimney pots entered large-scale production in Victorian times, becoming a feature of the skyline in towns and cities. Most pots seen today are 19th century or later. Tall chimney pots were sometimes introduced to reduce pressure zone problems or downdraughts (see section 4.3).

2.8 Parging

Chimneys were plastered or 'parged' internally to keep them air and watertight, as well as to insulate the flue and ensure a good draught. Parging of chimneys is documented from medieval times, such as in the contract of 1317 to plaster the walls and 'tewels' or flues to the summit of the Earl of Richmond's Hall in London. From medieval times, the mix used for 'parging' was a combination of lime (or earth), cow hair and dung.

2.9 Inglenooks and bread ovens

Bread ovens may survive intact in wide inglenook fireplaces which have been blocked when smaller fireplaces were inserted within them. Regional variations abound – bread ovens were commonly built into the side or back of fireplaces either as original features or later additions. Sometimes they comprised domed or roofed external additions (see figure 16). These ovens did not have their own flues. They relied on being heated by embers transferred from the main hearth or wood furze burned and the embers raked out once the structure of the oven was sufficiently warmed. The bread dough was then introduced to cook.

The construction of ovens depended on the availability of materials - brick being expensive for the average household until the late 17th century.[21] In cob and timber-frame areas where stone or brick were not readily available, clay or loam ovens were used.[22]

Many stone ovens decayed through successive heating so have been re-lined in brick. Doors were made of large stone slabs in areas of hard stone, such as granite in Weardale, and held in position by a loop of iron either side of the opening. Elsewhere thick elm doors, with a large vertical central handle to lift them into position, have been found, for example, in Wiltshire and Gloucestershire. Doors could be smeared with clay or dough to seal the oven. By the 19th century these were superseded by cast iron doors.

Figure 14: Eighteenth-century hob grate. Abingdon, Oxfordshire.

Photo: Sally Stradling

2.10 Firebacks

Wood-burning fireplaces were subjected to substantial heat, causing the bricks or stone at the back of the fire to become friable and collapse. Clay-tiled firebacks became fashionable - herringbone arrangements of tiles that could be fitted, and, if need be, replaced successively. In the Weald of Kent and Sussex blast furnaces had been active from about 1540, producing decorative cast iron firebacks. These protected the back of the fireplace from excessive heat as well as radiating heat. Early firebacks were long and narrow, later examples of taller proportions. Rope patterns were among those pressed into early firebacks, succeeded in the 17th century by often elaborate designs involving initials, coats of arms and dates.

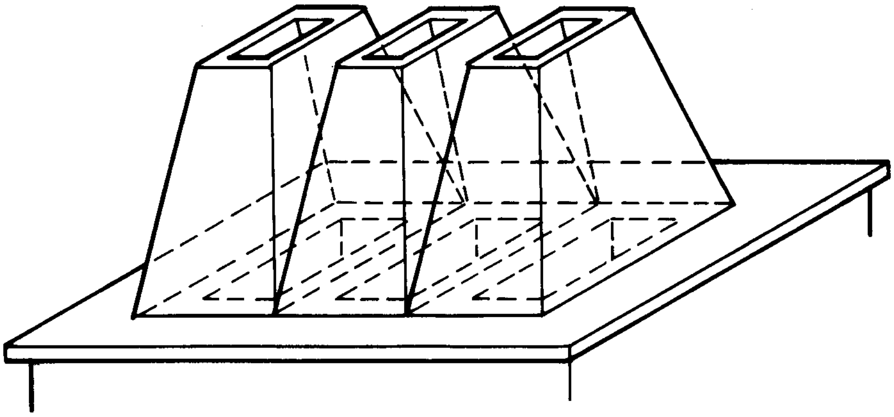

Figure 15: Gauger 'truncated pyramids'. Ilustration: Douglas D Kent, after Gauger, 1716

Figure 16: Bread ovens: **(a)** Bread oven 'bulge'. East Hanney, Oxfordshire. **(b)** Interior of bread oven showing brick lining. Old Priest's House, West Hoathly, West Sussex Photos: Sally Stradling **(a)** and Matthew Slocombe **(b)**

3 Work in general

3.1 Conservation approach

The demands of conservation impose additional considerations when working on an old building. In particular, a number of overriding principles should be borne in mind when working on old chimneys, together with the specific measures described in later sections.

A building's fabric is the primary source from which knowledge and meaning can be drawn. Materials and construction methods embodied in the fabric of a building illustrate changes in people's ideas, tastes, skills and the relationship with their locality. Fabric also holds character and beauty; the surfaces, blemishes and undulations of old buildings speak of the passage of time and of lives lived. Wear and tear add beautiful patination that new work can acquire only through the slow process of ageing.

The SPAB believes that the special interest of old buildings is best protected by maximising the retention of historic fabric. This is achieved through maintenance and 'conservative repair'.

The SPAB's view is that conservative repair is achieved by adhering to the following key principles:

- Carry out work essential to the long-term wellbeing of an old building.
- Employ compatible methods and materials.
- Obtain sound information about the history, construction and condition of an old building, as well as user needs, before making any serious interventions.

Listed building consent may be required from the local planning authority for work to an old chimney that exceeds like-for-like repair – if in doubt, consult the local authority conservation officer. It is a criminal offence to carry out work which needs listed building consent without obtaining it beforehand. Repairs are replacing a few bricks like-for-like; on the other hand, taking down and rebuilding an old chimney is demolition and rebuilding, and requires listed building consent. Building regulations approval may also be needed, for instance, for structural interventions.

3.2 Putting principles into practice

It is strongly advisable to obtain advice from a suitable specialist familiar with old chimneys when all but minor work is required (see section 13). Well-meaning but misguided interventions by those who lack the necessary skills and experience often lead to harmful work on old buildings. It is vital to identify the underlying causes of any problems and draw up a schedule of remedial action before embarking on work. This investigation may include smoke pressure testing a flue (see section 4.6) or inspection by camera. Bear in mind that where a stack forms part of a party wall, both parties will have to agree to any smoke test, because access will be required to the properties either side.

It is good practice to record the condition and appearance of a chimney before commencing work. Photographs are satisfactory in many cases but sketches may sometimes be helpful in addition.

An abstemious approach should be adopted that prioritises repair *in situ* over wholesale removal and replacement, which is justified only where absolutely necessary (see figure 17). Such an approach includes keeping, wherever possible, any cranes, smoke jacks, hooks and items of chimney furniture, for example, grates, firebacks, firedogs and baskets that have historic associations with the building. It also places an emphasis on the retention *in situ* of ancient burn marks found on timber lintels and thought to be a deliberate, superstitious effort to protect the occupants and their possessions. Similarly items such as shoes, clothing or mummified cats, tucked away in chimneys to ward off evil spirits, should be retained in their original position (except where a fire hazard when they should be photographed and recorded *in situ* and then kept somewhere safely in the house).

Never use strong Portland cement for work on chimneys and fireplaces. Lime-based mixes (without cement) are normally appropriate on older buildings pre-dating c1919 or, sometimes, earth-based mortar where this has been used previously. These traditional mortars will allow for expansion, contraction and permeability, thereby reducing the likelihood of the masonry cracking.[23]

Be aware that asbestos can be found in fireplaces and stoves, particularly register plates pre-dating about 1980, due to its heat-resisting properties. Before starting building work, check whether asbestos is present and act in accordance with the relevant Health and Safety Executive guidelines.[24] If you come across suspected asbestos-containing material unexpectedly during work, do not continue. Arrange for a sample to be taken by a competent person. Alternatively, presume that the material contains the most hazardous type of asbestos and apply the appropriate controls, using a licensed contractor, if required.

Figure 17: Repair is preferable to replacement, as with the repaired ends of this mantel beam. They respect the original but do not attempt to ape it. Photo: © Douglas D Kent

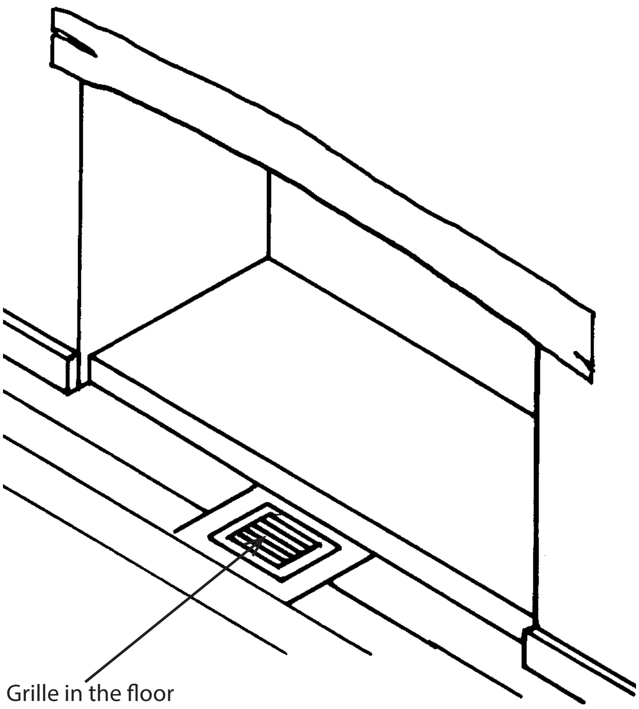

Figure 18: Floor grille to improve draught. Illustration: Douglas D Kent

4 Open fireplaces and inglenooks

4.1 Design

Open fireplaces were originally built oversized to allow wider logs to be burnt, thereby minimising the need for labour-intensive chopping. Hoods were wide to collect the smoke across the width of the fires. A flue narrows as it rises due to the corbelling-in of the masonry towards the top of the chimney structure. The flue, however, still has a large volume, which creates its own problems when making a fire draw. For this reason, open fires are relatively inefficient.

Where inglenooks and other features exist, careful consideration should be given to how they are retained and repaired. While there is a temptation to rebuild damaged or eroded features, it is very difficult to retain their authenticity once intervention begins. Many historic fireplaces have become poor replicas of their original forms through well-intentioned but overzealous 'restoration'.

4.2 Maximising heat output to an open fire

Users may obtain better heat output by taking the following into consideration (though this list is not exhaustive):

- Retain the ash under the basket or grate to act as an insulator. Do not light a fire on flagstones or directly against stone fireplace walls. The stone can explode violently in the heat, sending out dangerous hot fragments.
- Use a cast iron fireback to radiate heat back into the room (and, where the fireplace back is of stone, protect it from flames and the risk of explosion).
- Light your open fire at least one hour before sitting down to enjoy it. Keep it well-stoked.

If further measures are felt to be necessary to improve heat output, see section 4.3.

4.3 Improving the draw, reducing smoke

The inefficient design of the open fire makes it notoriously difficult to achieve a good 'draw'. Smoky rooms were part and parcel of life for earlier generations. An empirical rule governing the relationship of the flue to the fireplace is that the total volume of the flue should not be less than the total volume of the fireplace. Another empirical rule is that the area of the fireplace opening at the front should never exceed eight times the cross-sectional area of the flue.

Sometimes the lack of draw is the result of 'downdraught' caused by the proximity of trees, or the topography of the ground, for instance, adjacent slopes and hills. The closeness of other buildings may also affect downdraught, or even changes of roof level to the same building – this can influence the currents of air circulating around the top of a flue.

Historically, fireplaces were often in use continuously, whereas today fires may be lit only at weekends during the winter. It is harder to obtain a good draw until the flue warms up. Birds also can nest in chimney tops when flues are used less frequently, increasing the chance of obstruction.

Problems associated with a smoky chimney can usually be remedied without having to resort to rebuilding it by using one or more of the following measures:

- Have the chimney swept, cleared of any tarry deposits and checked with a camera to highlight possible blockages, especially at bends (see section 9.2). Ensure that the sweep is HETAS-registered and, similarly, that any engineer who advices on structural matters is experienced in the repair of old buildings.[25]
- Increase the updraught by improving air supply. Large flues need more air to prevent smoking but the supply may well have been reduced through improvements in draughtproofing. A further cause can be the presence of a mechanical extractor fan. The adequacy of the air supply can easily be tested by opening a window and seeing whether the chimney still smokes. If it does not, measure the gap around the window to calculate the additional air volume required.
- Drawing air across a room to a point of combustion creates an unwanted draught within the room. Consider carefully, therefore, where the air source is located; ideally, it should be as close to the hearth as possible. When an open fire is located within a recess, a vent should be outside the recess due to the risk of a draught pushing hot embers out of the grate. With a suspended floor, a grille can be inserted immediately in front of the hearth (see figure 18). The combined unobstructed cross-sectional area of the inlets should not be less than the cross-sectional area of the flue. **Note:** If the floor is being replaced, the opportunity should be taken to incorporate a suitable duct to draw air from outside to the point of combustion. The removal of overzealous draughtstripping around windows and doors can also help cure less serious cases of air starvation.
- Reduce the demand for air or streamline a badly formed throat. Voids within the flue are filled with brick or rubble bedded in lime mortar and given a lime plaster finish, while also fitting a throat restrictor (blister) – a metal plate on the backwall of the chimney to reduce the fireplace dimensions to approximately 600 x 900 mm. This improves the draught by creating a throat further up and allows the flue to cope better with variations in wind speed (see figure 19). Carry out a test first using cardboard or thin metal sheet.
- For persistently smoky larger fireplaces with an opening more than eight times the flue size, install a canopy (or larger canopy) to collect smoke and funnel it up the chimney. A metal register plate is fitted at the base of the flue with a hole of 300 mm minimum diameter into which goes a metal pipe of the same dimension, projecting upwards into the flue. At the bottom of

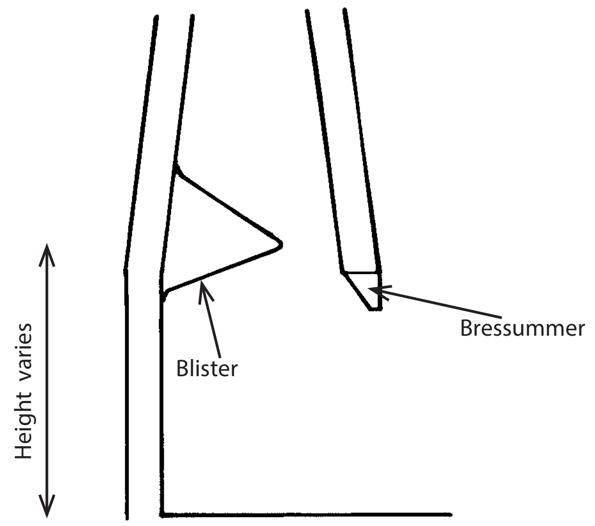

Figure 19: 'Blister' fitted inside inglenook fireplace.
Illustration: Douglas D Kent

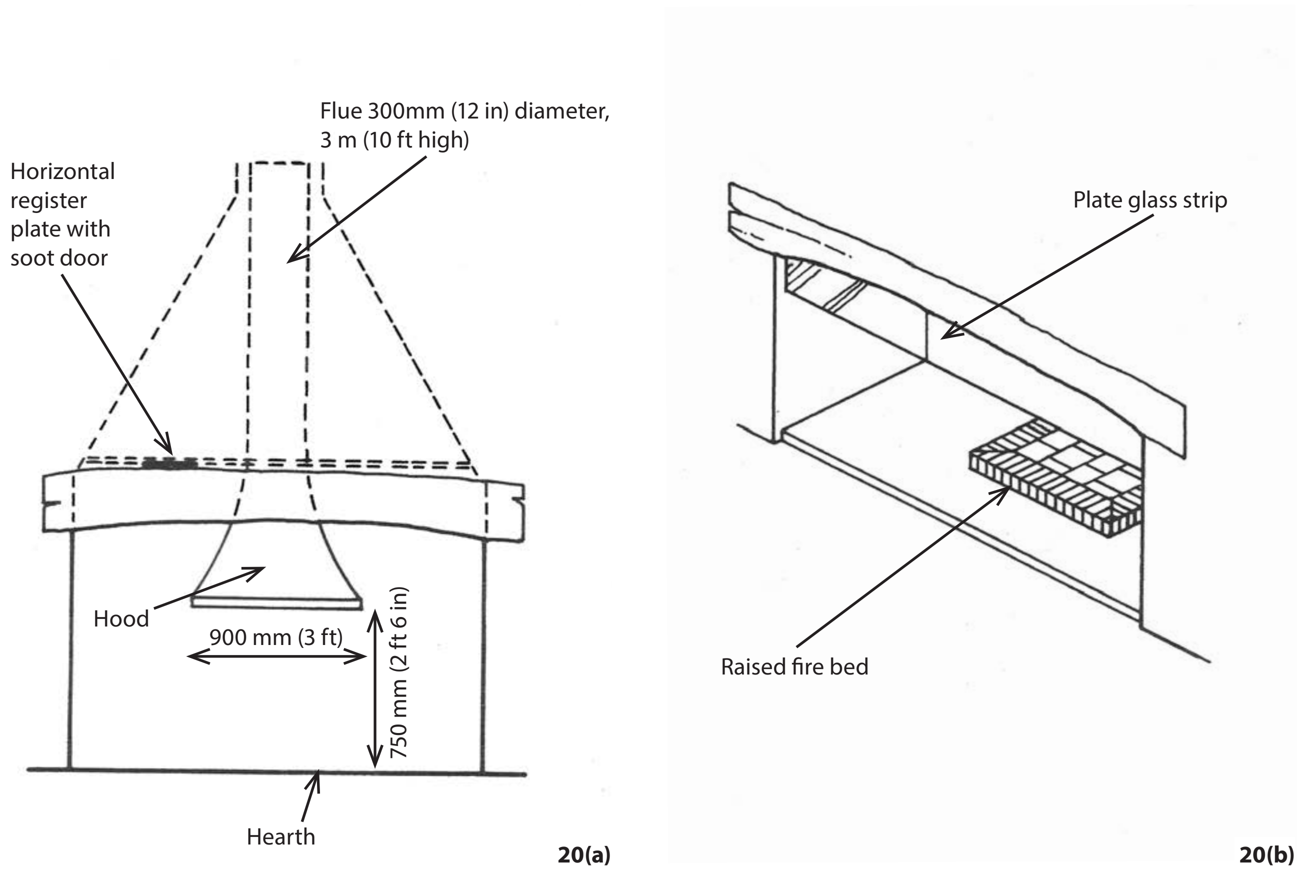

Figure 20: Methods of reducing smokniess arising from large fireplace openings: **(a)** Insertion of hood. **(b)** Raised firebed.
Illustrations: Douglas D Kent

the pipe an iron or copper canopy is fitted finishing about 750 mm above the fire bed and measuring about 900 wide by 600 mm deep. The exact dimensions will reflect the size and proportions of the fireplace opening (see figure 20(a)). The canopy should be designed by someone experienced to ensure the correct form. This arrangement should also incorporate a butterfly valve to shut off the downdraught when the fire is not in use. The canopy solution can also overcome the problems associated with a shallow fireplace opening, by projecting further into the room.

- Install a canopy to reduce the effective height of a fireplace opening to 600 mm where it exceeds this. Alternatively, a copper, iron or glass panel can be fitted across the top of the opening. Such a modification should always be ‘mocked up’ and tested in advance of fixing a permanent strip to check its effectiveness. A further option is to experiment with raising the level of the grate to reduce the distance between the fire and base of the flue (see figure 20(b)). This can be done initially on bricks.
- Add a cowl. Alternatively, a stone cap raised on corner bricks (a ‘dovecote’ terminal) insert can be built over the top of the stack, though this is inadvisable on thatched properties (see figure 21). Such measures frequently help overcome downdraught that is resulting in puffs of smoke or fumes into a room, usually intermittently, where wind blows over a nearby tall building, tree or hill and down into the chimney. With a cluster of chimney pots where smoke from one enters the top of another, raise the level of a pot or, with a disused flue, provide a cap.
- Increase the height of the chimney stack and/or install a tall pot, with listed building consent. This is often the most effective solution should pressure zone problems cause puffing or the continuous emission of fumes where the chimney is exposed to the prevailing wind. It may also overcome downdraught. The diagnosis is confirmed if opening doors and windows on the exposed side equalises the pressure and creates updraught. As a last resort, a non-traditional remedy, particularly with a short length of flue, is to install within the chimney capping a proprietary extract fan designed so that in the event of failure a proportion of the products of combustion can still escape the flue. All these options will require listed building consent.

Figure 21: A 'dovecote' top can be used to protect large flue outlets from wind and rain, though is inadvisable on thatched buikdings. A stone slab is placed above the flue opening raised on bricks at the corners. Such terminations should incorporate suitable bird mesh to stop nests being built under the slab. However, addition of a slab roof may affect the draw in certain situations. Always light a fire and check for unintended consequences before striking the scaffolding around the stack. Photo: Marianne Sühr

Figure 22: Spalling brickwork to inglenook fireplace due to aggressive cleaning. Photo: © Douglas D Kent

4.4 Opening up blocked fireplaces

Fireplaces in old buildings were often altered over the centuries as new fashions and technologies evolved. Early fireplaces may have been superseded with later versions, or the opening blocked entirely.

It should be emphasised that the principal reason many inglenooks were infilled was to improve the efficiency of fireplaces and their draw as occupants became less tolerant of smoky rooms and poor thermal performance. Before embarking on any alteration, be warned that the outcome may be less satisfactory than the present arrangement! Consider when and why an inglenook was blocked and the historical value of later insertions or alterations. The local planning authority's conservation officer should be consulted because consent will be required for these works if the building is listed and there is sometimes a requirement for an archaeological watching brief.

Spalling to bricks around open fire

The faces of bricks frequently become powdery (spall) after they have been subjected to aggressive cleaning, for example, sand blasting. Spalling can be difficult to stop but a 15-20% dilution of potassium silicate may be soaked into the face of the bricks to help densify them. Potassium silicate is moisture open and, as the binder is often used to make fire cement, is safe to use near heat. There is very little to no visible change to the colour or surface texture when using potassium silicate (see figure 22).

While exposing an early fireplace is now often seen as desirable, it is possible to destroy historic detail in the process. Early plaster and decorative paint schemes may be present and should be conserved. The fashion for exposing masonry by stripping these finishes is completely at odds with historical authenticity. Traditionally, the masonry around a fireplace would have usually been plastered or at least limewashed. This was a protective layer and helped to prevent spalling.

Additionally, consideration should be given to whether the masonry that blocks an earlier opening is forming a structural support (see figure 23). Before masonry is removed wholesale, a trial removal of one or two masonry units could help ascertain structural stability. This investigation, often in conjunction with a camera, can also assist with establishing the condition of the flue, lintel and support, as well as determining whether the removal of later inserted material could result in collapse of masonry above. Advice should be sought from a suitably experienced structural engineer where the integrity of a structure is in doubt.

4.5 Cracking in fireplace masonry

It is not unusual to find wrought iron flat plates or angles built into brick fireplaces to support the masonry above. These often have surface corrosion, which can be the cause of very slight, localised jacking of the masonry (see figure 24). Thermal movements within the iron can be another cause of localised cracking, although their effects are usually not significant. It is often best to accept and tolerate such minor cracking.

Figure 23: Later fireplace in earlier opening.
Photo: Marianne Sühr

Figure 24: Cracking to chimney brickwork.
Photo: © Douglas D Kent

4.6 Smoke pressure testing of flues

Ideally, testing should be carried out by a HETAS-registered or other accredited engineer, chimney sweep or chartered building surveyor.

Smoke testing a chimney is very useful to determine its condition. This is especially so after a period of inactivity or where the possibility of leakage of the flue gases needs to be determined.[26] A simplified version of the test is detailed below:

- If there is an appliance fitted at the base of the chimney, burn some seasoned kindling on the fire or grate for two to three minutes to establish a flue draw. A longer warming-up time may be needed with wet or cold flues (please note that this will not replicate the temperature or volume of hot gases that would normally be created while a heat-generating source is in use, but is still useful).
- Place two smoke pellets on a brick (or similar) in the opening at the base of the flue or in the appliance, if one is fitted. Follow the smoke pellet manufacturer's safety instructions.
- Ignite the pellets and when the fire starts smoking close the opening with a board or plate sealed at the edges or, if an appliance is installed, close all doors, ashpit covers and vents.
- When smoke begins rising out of the chimney top, seal the top of the flue, terminal or pot. There are products on the market specifically designed for this purpose, though an inflated football bladder or plastic bag sealed in position with tape are alternatives.
- Examine the full length of the chimney for any leakage of smoke (including, where relevant, cavities at the back or sides of the chimney, in the roof space and around windows).
- Remedy any points of leakage using technically and aesthetically appropriate materials and repeat the test (remember to remove the bottom and top closers upon completion of the test).

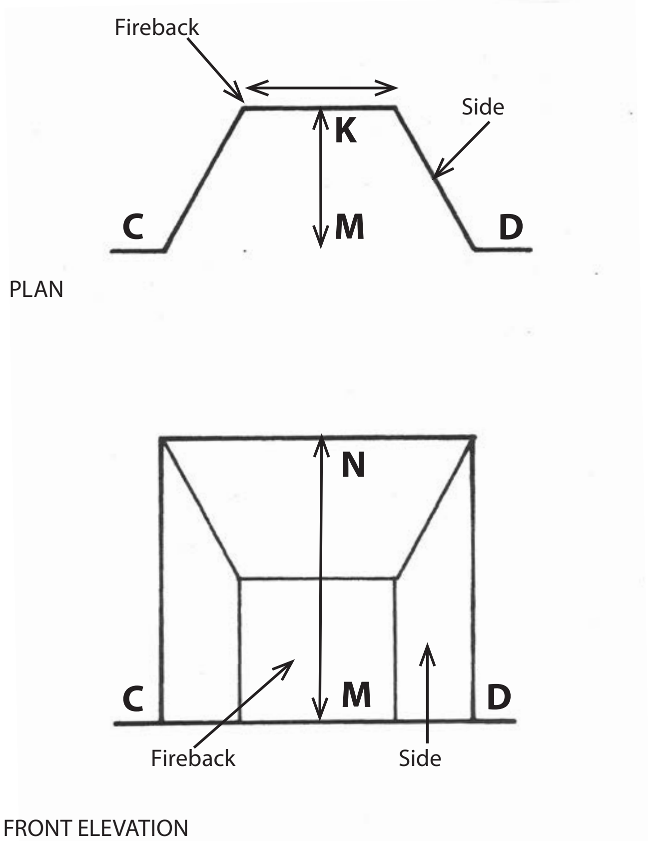

Figure 25(a): Count Rumford's principles: Correct proportions for a fireplace opening. Dimensions C-D and M-N to be twice the depth of M-K.

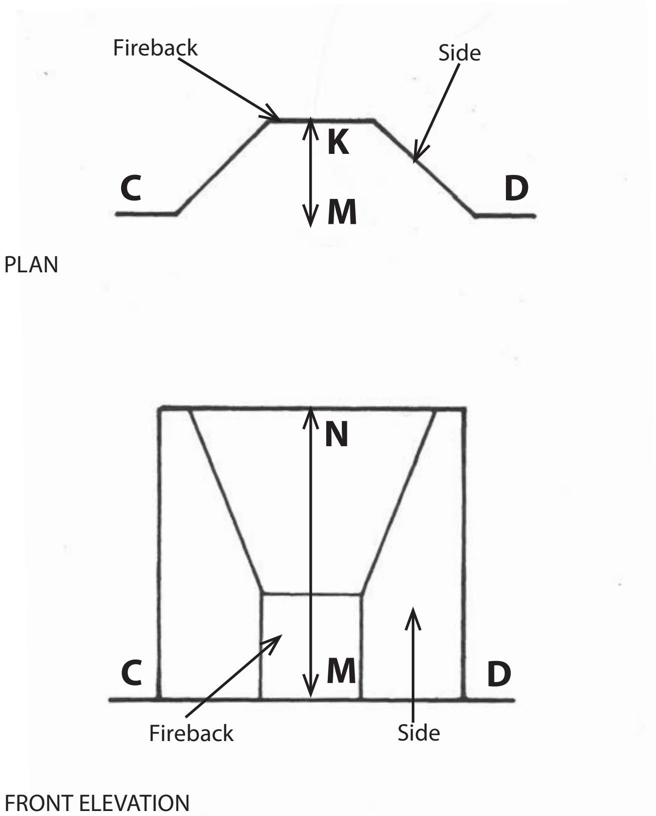

Figure 25(b): Alternative proportions. Opening C-D to be three times the depth M-K.

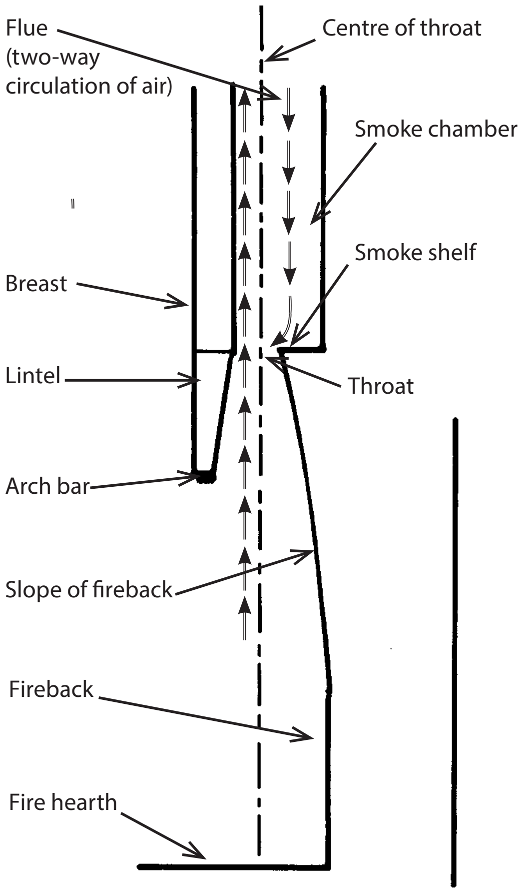

Figure 25(c): Circulation of air above smoke shelf.

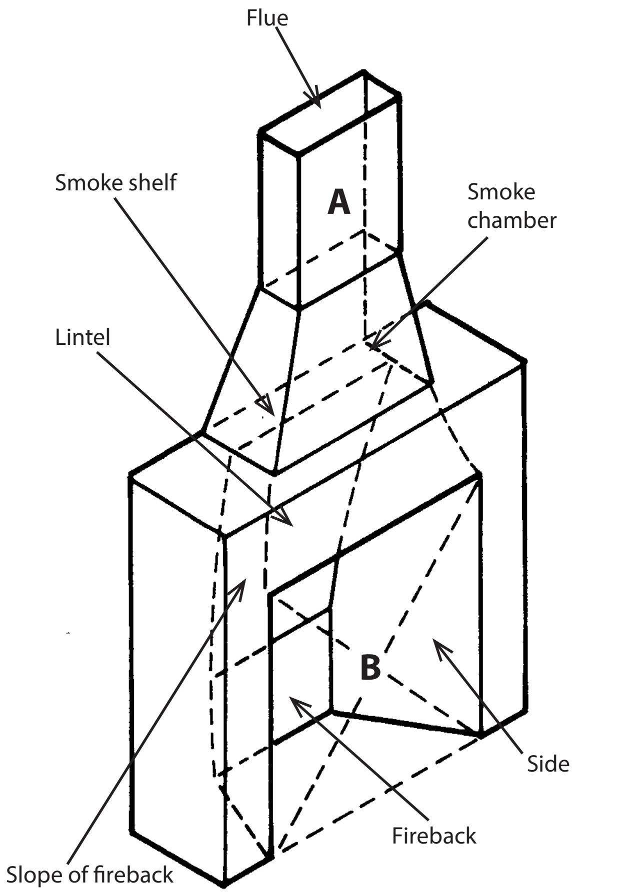

Figure 25(d): The inside area of the flue A should be one-tenth of the area of the fireplace front opening B.

Illustrations: Douglas D Kent

5 Hobs and grates

5.1 Advancing technology

From the late 17th century onwards, fireplace technology evolved rapidly. While open fires based on the traditional inglenook continued in humbler dwellings, those who could afford to do so opted for cast iron hob grates that were more efficient, along with purpose-designed kitchen ranges combining cooking and heating. A hob grate consisted of a small raised grate for the use of coal with hobs (shelves) either side, which were used especially for heating pans.

5.2 Count Rumford

The work of Count Rumford in the 1790s applied mathematical formulae to fireplace design, aimed at improving the efficiency of the draw and reducing the potential for smoking and downdraught. His influential writing (and developments from it by others) largely dictated the design of chimneys throughout the 19th century. The development and mass production of cast iron hobs and grates provided the impetus for the infilling of many earlier inglenook-style fireplaces to improve efficiency.

A summary of Count Rumford's design principles is as follows (see figure 25):

- The inside cross-sectional area of a flue should be one-tenth of the area of the fireplace front opening, and be square in cross-section.
- The fireplace front opening should have an equal height and width.
- The depth of the fireplace should be between one-third to one-half of the width of the front opening.
- The sides of the fireplace should be splayed to reflect the heat into the room.
- The upper half or two-thirds of the fireback should be sloped outwards, also to reflect heat out into the room.
- Centrally above the fireplace should be a restricted throat, 4 in (100 mm) from front to back, with its width determined by the splaying of the sides and back of the fireplace, and lintel over the fireplace opening.
- Level with the restricted throat should be a smoke shelf. The purpose of this is twofold: to prevent soot and rain from falling into the fireplace and, more importantly, to cause a two-way circulation of air in the flue.
- Immediately above the restricted throat there should be a smoke chamber, the same depth as the flue, and with its sides tapering inwards at an angle of 60˚ until the flue is reached.

5.3 Reinstating hobs and grates

Many original hobs and grates have been replaced with later fireplaces or blocked up entirely. Certainly, with the advent of central heating, open fireplaces became generally redundant in areas other than sitting rooms, though is still possible to find the remains of a grate behind a plasterboard panel in a bedroom. Survivals are precious and should be retained and carefully conserved.

Original grates can frequently be repaired by specialist cast iron repair firms, which is always preferable to replacement. If a new grate is required it is useful to understand the past form and development of the fireplace. This can help inform the design or choice of an appropriate and efficient modern grate.

Where necessary, old hob grates may be adapted to burn smokeless fuel. Conversion can be done inexpensively by the following method (see figure 26). Smokeless fuel needs a very small controlled air flow both to and from the fire. The traditional hob grate provides an almost unlimited flow of air from beneath. This can be controlled by fixing a sliding drawer (A) on the underside of the grate which prohibits upflow when closed, but can allow a desired amount of air by slightly pulling the drawer forward.

To produce a combustion chamber, a thick metal plate (B) is fixed between the sliding drawer and the first bar above. The chamber can also be reduced for economy's sake by bedding an additional firebrick back (C).

A hob grate requires an excessively large chimney mouth, which draws out too much air for combustion and so lowers the temperature in the room. These defects can be readily overcome by placing an iron sheet (blister plate) (D) across the opening, curving up from the back of the grate to the inside of the fireplace lintel. The centre part (E) is cut and bent back to provide a limited access opening to the flue above. The sheet of iron becomes warm and conducts the smoke up to the opening.

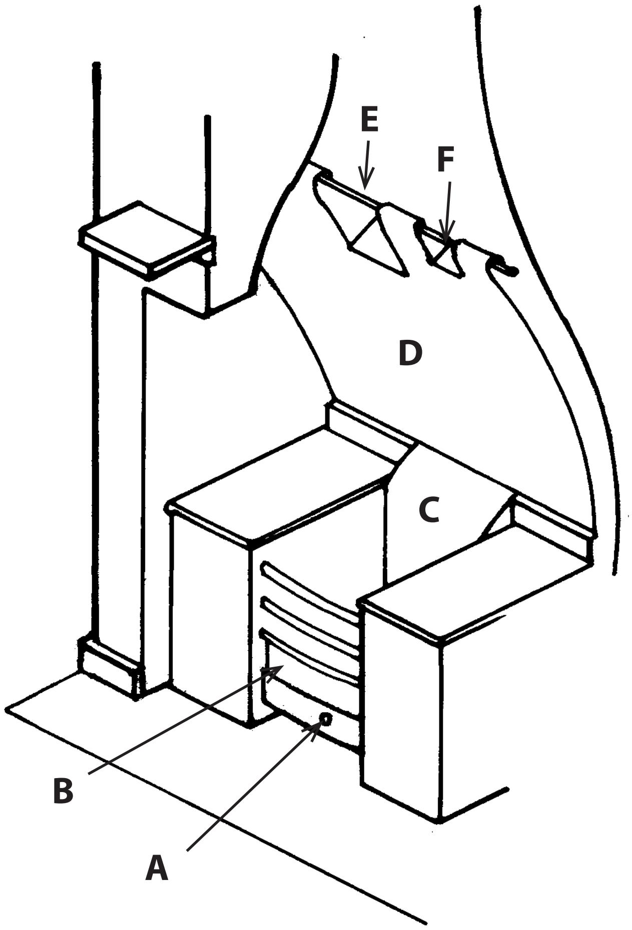

Figure 26: Converting a hob grate to burn smokeless fuel. Illustration: Douglas D Kent

It may be found that smoke tends to hang at either end of the lintel in which case two small exits (F) can be provided in a similar manner. A strip of iron should be rivetted along the top of the sheet to hold its parts in proper position, and the whole sheet fixed to be readily removed and allow the flue to be swept.

Architectural salvage yards

While there is a temptation to purchase a historic fire grate from an architectural salvage yard, do consider the provenance of such an item. It is often the case that a missing grate is the result of architectural theft, and to purchase one from a disreputable yard will fuel the market encouraging such crime. If the seller is unable to provide a history of the item, then consider looking elsewhere.

Cast iron can be repaired (and will be covered by a future Technical Advice Note).

5.4 Energy efficiency when not in use

Old cast iron fireplaces frequently have inbuilt dampers to cut draughts when not being used. Dampers are not incorporated in new stoves today because of the risk that they will accidentally be left closed. Where one is present, however, it is important to allow a continuing small flow of air to ventilate the flue when the damper is closed, thereby minimising the risk of condensation.

Fitting a chimney balloon is another option when a fireplace is not in use. It is inflated to push against all four walls of the chimney and hold itself in place. There is a small vent in the side of the balloon to permit some airflow. Chimney umbrellas or wood draught excluders are alternatives. A more traditional solution is to place scrunched up newspaper into the chimney to stop unwanted draughts.

6 Flues

6.1 Traditional chimney lining

It was not until the 1965 Building Regulations that there was a stipulation that all new flues have an inbuilt liner. Prior to this date, however, there was already a very long tradition of lining chimney flues. The traditional method using a mix of lime putty and fresh cow dung, known as 'parge', was still being employed, almost universally in domestic buildings, until relatively recently (in the 1950s it was still normal practice for housing estates in south-east England).

The work was done by bricklayers (or their labourers) as the flue was built up. A typical mix consisted of 1 part of lime putty to three parts of cow dung but references to other mixes exist, such as 1:1 and 1 part cow dung to 4 parts of haired lime mortar (comprising 1 part lime to 3 parts sand plus 1 lb (454 g) clean, well-beaten bullock's hair for each two cubic feet (0.06 m^3) of lime).[27] The purpose of all the mixes was to give an exceptionally sticky daub with a high proportion of fibre usually applied to a nominal thickness of about 13 mm. This created a render on the internal masonry face of the chimney.

The addition of animal hair as fibre mitigated the effects of shrinkage cracking as the material dried. The dry material has a low density and serves to insulate the flue as well as prevent leakages.

Once the stack was completed, the flue was cored (or cleared) by passing a wire brush or 'core' through the length to remove the bundle of rags or shavings called 'sweep' or cripple', which was placed inside the flue to prevent blockages that might be created by falling deposits of mortar, daub or masonry. The labour time taken in parging and coring a 10 ft (approximately 3 m) length of 9 in by 9 in (approximately 225 by 225 mm) flue was estimated at one hour.

6.2 Grouped flues

As fireplaces became more common, particularly in Georgian and Victorian buildings where more rooms were heated, the complexity of flue and chimney structures increased. Grouped flues sitting side by side are separated by withes (or mid-feathers). These are the division between flues within one chimney stack. Withes are often slender and may be constructed in numerous ways. Common examples include:

- Single thickness of brick (commonly laid on edge).
- Thin, cut stones (often vertically or face-bedded).
- Slate.


27(a)


27(b)

Figure 27: Withes: **(a)** Part-dismantled during repair. **(b)** After repair.

Photos: © Paul Carlier

Because of their slenderness, withes are susceptible to damage when a chimney is swept, especially at bends or with unusual flue configurations. Mortar within withes is also liable to attack from acidic flue gases, especially when both sides of a flue are in use. As a result, individual masonry units may become loose. Vertically bedded stone and slate is vulnerable to lamination and more likely to decay.

Where an unlined flue is in use, it is imperative that the condition of the withes is inspected regularly, ideally with cameras in inaccessible areas, and necessary repairs undertaken (see figure 27). Where there is any doubt, a smoke pressure test will show the integrity of the mid-feathers. Failure of the withes can lead to leakage of smoke and gases into neighbouring flues and rooms, with potentially serious consequences.

6.3 Retrospective chimney lining

Building owners commonly feel the need to line the flues of traditional open fires with a modern proprietary system but this is usually misguided and unnecessary. Not only can lining of flues affect the draw detrimentally, it may also lead to moisture ingress. Many systems (such as ceramic and pumice liners) are permanent, and, if they have a negative effect on the functionality of the fire and stack, they are difficult, or even impossible, to remove later.

Over the centuries, due to expansion and contraction of the flue, attack from acids and tars produced during combustion and the damage caused by sweeping, the original lining parge coat tends to detach itself from the flue walls or erode back, leaving bare masonry and the risk of smoke and fumes leaking into other parts of the building, as well as the possibility of any embedded timber catching fire.

A camera inspection and smoke test will establish the general condition of the parge and, where exposed, the masonry structure. Where the parge is damaged or missing, it is important to ascertain whether there are any holes leading from the flue. Where the pointing to the flue is sound, it may itself be adequate to contain the smoke and combustion gases, depending on its condition.

Figure 28: Re-parging of flue: **(a)** Winch for drawing up sponge. **(b)** New parging mortar applied. **(c)** Only one flue remains in use, the other flues have not been relined.

Photos: Philip Hughes

6.4 Traditional re-parging to flues

If the lime mortar parging in a chimney flue has been lost, then the best option, where possible, is often to replace it with a traditional mix. This has the following benefits:

- The parge lining will close any breaches of the flue wall and contain the smoke.
- The flue walls remain breathable and able to deal with moisture movement through the stack, especially where no damp-proof course is present.
- Where the flue is open at the top and has no rain guard, the absorbent surface of the parge lining absorbs the small amount of rainwater running down the flue before it reaches the fireplace.
- The replacement of the parge will not reduce the cross-section of the flue – this may be an important factor when making the fire draw.
- The area directly above a large open fire or inglenook is usually spacious enough to stand in and re-parge with a trowel. The inaccessible walls of the flue higher up, though, are trickier to deal with.

Where flues are of large enough diameter, ladders or platforms may be erected to undertake the work physically using traditional plastering techniques. Where flue diameters are smaller, then it is possible to re-parge using a specially shaped sponge or 'former' drawn up through the flue to compress mortar against the flue walls. This technique is carried out by erecting a scaffolding around the stack and accessing the flue from above (see figure 28). The method is outlined below:

- Make sure the chimney has been swept thoroughly.
- Remove loose/damaged material prior to commencing re-parging and dampen down the flue walls.
- Apply the parging mortar directly, or load it down the flue onto the sponge and then drawn this up repeatedly to compress the mortar against the flue walls.
- Where there is a change in direction, then an opening will usually need to be made into the flue to enable the parging of each section to be completed.
- The opening then needs to be made good.
- When the mortar is fully set, smoke-test the flue to ensure there is no leakage of fumes.

6.5 Reasons an alternative lining may be needed

While, wherever possible, missing areas of parging should be renewed using a traditional lime-based mix as described in section 6.4, the use of an alternative, modern lining system may need to be considered to improve the safety or efficiency of a flue in certain circumstances, particularly with wood-burning or multi-fuel stoves.[29] The insertion of a modern retrospective liner may be justified where:

- **The flue is leaking smoke and fumes into other parts of the building.** This usually occurs where traditional parge lining to the flue has begun to break down, or deterioration or alteration of the chimney stack masonry has occurred. Where access is not possible for repair, then a flue liner might be the only option.
- **Condensates or tar are seeping through the chimney walls.** This is particularly common with wood-burning heat sources and prevalent where construction defect-related moisture ingress has occurred, for example, with deteriorated flaunching, or condensation is present. The problem is exacerbated in historic buildings because chimney stack masonry is often laden with the tar of hundreds of years of burning wood in fireplaces and the presence of excessive moisture is likely to mobilise these. Tar deposits can ignite and cause chimney fires.
- **An insulated lining is needed to improve the operation of the appliance or flue.** For a flue to draw the by-products of combustion efficiently, it should be kept warm and this is directly related to the difference in temperature between the

Parging mix

The following parging mix has been found to produce promising results in trials:[28]

3 parts coarse stuff (1:3 lime putty: haired aggregate) 1 part fresh cow dung

Each 100 litres of coarse stuff to contain 0.5 kg of hair. Coarse stuff to be thrown on rather than trowelled.

flue gases and the air outside. A traditional open fire, where a large quantity of the hot air rises through the stack, keeps a flue relatively warm but where high efficiency heat generators (such as wood-burning stoves) are introduced, they can lower flue temperatures, reduce draw and increase the risk of condensation. Where stacks are exposed to the exterior on any side, the potential for reduced flue temperatures and condensation-related problems is exacerbated. Insulated chimney linings, therefore, have the potential to make the flue draw more efficiently and reduce the risk of condensation-related problems.

- **Poor updraught exists due to frictional resistance.** This may occur because the surface of the flue lining has been eroded, has a rough texture and access for repair is not possible.
- **The flue is too large for the type of fire or appliance fitted to be used efficiently.** For instance, an inglenook fireplace is retrofitted with a wood-burning stove. A gas boiler may also, under certain circumstances, utilise an existing flue.
- **Building regulations compliance is needed.** A material change to an appliance or chimney will mean the complete combustion system has to comply with current building regulations. This may necessitate a new liner as a way of creating the minimum 200 mm distance to combustible material between the flue interior and chimney masonry prescribed in the regulations.
- **The presence of combustible historic materials.** Early timber-framed smoke hoods are important and rare survivals. They may survive disguised as normal chimneys with fireplaces installed at low level and masonry stacks above. Smoke bays may be found lined with layers of haired render but it is prudent not to rely on such ancient linings alone for fire protection.

6.6 Alternative lining systems

Where the use of an alternative to traditional lime parging is unavoidable, various options exist (and can be used singly or in combination). Bear in mind that these may have a detrimental effect on both the longevity of the masonry and the draw of the fire. The installation of an alternative lining system is therefore not something that should be entered into lightly. Always ask the question: 'Can I remove it if it doesn't work?'

Generally, any sort of lining inserted into an old flue should be fully reversible. To minimise problems with moisture, the liner should be surrounded by either a cavity or material that is breathable.

Where a pre-insulated twin-wall metal liner is used to enable a reduction of the minimum distance of 200 mm stipulated in the building regulations from the inside surface of the flue to combustible materials, it is prudent to back-ventilate the void (top and bottom) between the lining and chimney masonry. This is because such liners are often tested by manufacturers on this basis and rely on the resultant cooling but it is not always made clear.

It is advisable to insulate, or use pre-insulated, flexible liners to keep flue gases warmer, achieve a good updraught and reduce the likelihood of condensation with chimneys that are on outside walls or have tall stacks or wide flue diameters. Where the space around a lining is backfilled with loose-fill insulation, this should be breathable but not hydrophilic (moisture-absorbing), as well as incombustible. Foamed glass or expanded clay beads are ideal for this situation. They should not be mixed with mortar, otherwise eventual removal of the liner will be impeded.

Figure 29: Flexible metal liner being inserted into chimney of thatched cottage to serve new gas stove after removal of a wood burner to reduce the fire risk.
Photo: © Catherine Peacock

With flexible liners, care must be taken during installation to maintain a distance of at least 200 mm for the full length from the inside of the flue to the outside of the chimney masonry.

The advantages and disadvantages of the different modern lining systems available are given in appendix A. Twin-walled insulated rigid stainless steel liners can provide a good means of lining old chimneys retrospectively but flue geometries and access limitations often preclude this solution. Good quality flexible stainless steel liners may offer an acceptable alternative (see figure 29), as can other systems in certain circumstances.

Other lining systems include the use of pumice or clay interlocking liners, which have the benefit that they can negotiate bends, but are not normally reversible.

One common system, heavily marketed, is to line the flue with an impermeable skin that is heated and expanded under pressure (rather like a sausage-shaped balloon) to form a thin, close contact layer against the masonry. This may appear to be a good solution for preventing the leakage of smoke and gas, but wind-driven rain can pass through the masonry of the exposed chimney stack and become trapped between the inner faces and the lining. This may cause frost damage due to saturation of the masonry, as well as lead to moisture trickling down into upper rooms where the two materials meet. Although many such systems are not adhered physically to the flue, and therefore technically reversible, they are difficult, if not impossible, to remove where flue access is limited. There are also concerns about what would happen to such linings during chimney fires.

Before relining, it is essential to have the chimney swept thoroughly, the condition of the stack checked with a smoke pressure test and any remedial measures, such as repairs to brickwork, carried out. If no chimney pot is to be provided, at least 100 mm of liner should be left projecting above the flaunching. This creates a turbulence that can assist the draw in strong winds and reduces the likelihood of rainwater or snow being blown across the flaunching into the flue.

Relining can lead to rainwater dripping down into the fireplace, so some manufacturers require that a rain cap is fitted to prevent this. This is inadvisable, however, with solid fuel appliances where a building is thatched because it can increase fire risk (see section 10.4).

7 Solid fuel appliances

7.1 Considerations before installation

Wood-burning and multi-fuel stoves have become increasingly popular in recent decades as a more efficient means of heating rooms. It is particularly common for stoves to be inserted in inglenook-type openings where greater heat output is required. However, energy efficiency needs to be balanced against possibly increasing fire risk.

The following should be borne in mind when considering fitting a wood-burning or multi-fuel stove:

- The incorrect installation or use of wood-burning or multi-fuel stoves can substantially increase the risk of fire or lead to flue gases being discharged into rooms. The installation or use of such stoves is strongly inadvisable in thatched buildings (see section 9.3).
- If the building is listed, listed building consent is required.
- Always use a HETAS-registered installer or equivalent accredited installer to install a stove and advise on chimney safety, repairs and ongoing maintenance.
- The presence of wood-burning stoves will need to be declared when seeking building insurance and failure to do so may invalidate a subsequent claim.
- The insurance company will require certification of correct installation before providing cover. The works can be signed off through HETAS by a competently trained and registered installer, saving on cost. The local authority building control department can also provide certification that a stove has been fitted correctly.
- Unlike with traditional open fires, the insertion of a liner is generally advisable with modern stoves. Where this is carried out retrospectively, for instance, in a former inglenook opening, it is recommended that a twin-walled metal liner is used.
- Always terminate the stack or pot with a bird guard and, unless the building is thatched, a rain cap to stop water running down the impermeable flue liner. Ensure guards and caps are cleaned regularly.

- Fit smoke alarms and a carbon monoxide alarm in the room where the solid fuel appliance is installed.

7.2 Inspection of existing stoves

Importantly:

- Take care when inspecting an existing register plate. Many of these were made from fire-resistant asbestos cement panels but often painted black to resemble metal. If you tap them, it should be apparent whether they are metal or an alternative material. If in doubt, appoint an asbestos consultant.
- The flue pipe and stove should be no closer to combustible materials, such as timber beams, than advised by the manufacturers. Some supply heat shields to reduce distances in challenging installations.
- Use a camera to check the condition of the liner. Soot can settle on the corrugated surface of a flexible liner and be difficult to remove by sweeping. It may be necessary to remove the liner.
- Flammable tar can build up to reduce the working diameter of the flue or corrode a flexible liner. This is particularly dangerous if the temperature of the stove is not monitored and why the chimney should be swept regularly.
- Ideally, liners should be insulated to avoid condensation in the flue, which accelerates the formation of tar.

7.3 Safe use of wood-burning and multi-fuel stoves

Points to consider are:

- Only use fuels which are recommended. Ensure both kindling and logs are seasoned. (See section 8 and paragraph 2 of section 9.1.)
- When lighting a stove, follow the manufacturer's instructions. Turn the vents down once the fire is underway to avoid dangerously high temperatures within the flue.
- Always use a chimney thermometer with a wood-burning or multi-fuel stove and monitor the temperature of the burn. If the fire burns too cold (below 110 °C), there is a risk of tar formation. If it burns too hot (above 240 °C), there is a risk of fire. **Note:** If the glass is turning black, then tar is almost certainly forming on the flue walls.
- Sweep chimneys regularly (see section 9.2).
- Make sure the property is insured adequately, especially with listed buildings.
- Ensure sufficient ventilation and fit a carbon monoxide detector at sitting level near the fireplace.

7.4 Ventilation for wood-burning or multi-fuel Stoves

Generally, regulations do not require additional room ventilation for a stove sized 5 kW or under in an existing building. Greater ventilation may be required, however, where a property undergoes refurbishment or an extra open-flued appliance is fitted. Always check with your building control officer.

Types of firewood

Historically, the knowledge of timbers for fires was well-known and a number of popular rhymes describe the virtues of various species when used as a fuel:

'Beechwood fire burns bright and clear, if the logs are kept a year.
Store your beech for Christmastide, with New Year holly cut beside.
Chestnut only good, they say, if for years 'tis stored away.
Birch and firewood burn too fast, blaze too bright and do not last.
Flames from larch will shoot up high, dangerously the sparks will fly,
But ashwood green and ashwood brown are fit for a queen with a golden crown.

'Oaken logs, if kept dry and old, keep away the winter cold.
Poplar gives a bitter smoke, fills your eyes and makes you choke.
Elmwood burns like a churchyard mould, e'en the very flames are cold.
Hawthorn bakes the sweetest bread, so it is in Ireland said
Applewood will scent the room, pearwood smells like flowers in bloom.
But ashwood wet and ashwood dry, a king may warm his slippers by.'[30]

8 Fuel for stoves and fires

8.1 What to burn

Timber should be carefully selected for burning, and stored and seasoned correctly. This is vital to minimise issues such as tar deposits, which increase maintenance and repair requirements, make it harder for chimney sweeps to keep systems in a safe, effective condition, lead to chimney fires and shorten the life of metal flue liners, where present. The moisture content of timber will also affect the efficiency and heat output of the burn. Check the moisture content of timber is below 20%, using a probe available from most builder's merchants. Alternatively, buy kiln-dried wood from a reputable source.[31] Store this undercover in an airy ventilated position.

Softwoods, such as spruce and pine, burn much faster than hardwoods, for example, oak. Softwoods also spit a lot so are best suited for kindling and closed stoves. Burn hardwoods in open fires. As a rule of thumb, twice as much softwood is required than hardwood to achieve the same heat output.

The source of timber should also be a consideration and the use of coppiced wood chips or timber from a sustainable forestry scheme is preferred because of its long-term sustainability.

8.2 What NOT to burn

Remember:

- Wet wood is not suitable for burning without further seasoning. If black smoke is being created, then tar is almost certainly forming on the walls of the flue. Wood sold in volumes of up to 2 m^3 must be certified as having a moisture content of 20% or less.
- A fire must not be used like an incinerator by burning rubbish, paper or Christmas wrapping. The sparks from such lightweight fuels can travel further and potentially ignite a thatched roof.
- Do not burn treated or painted timber as the chemicals can lead to the formation of tar deposits and noxious gases.
- In a smoke control area, unless you are using an 'exempt appliance' you can burn only fuels on the list of authorised fuels or anthracite, semi-anthracite, gas or low volatile steam coal.[32]

9 Fire safety and chimney sweeping

9.1 Causes of chimney fires

The principal cause of chimney fires is associated with burning unsuitable material as fuel. This leads to a build-up of soot and tar in flues, which will ignite under certain conditions. Old flues should be swept regularly and diligently to prevent soot build-up if chimneys are lit throughout the colder months (see section 9.2). **Note:** Many chimney fires occur between January and March.[33]

If damp timber is used, the water vapour produced from the burn combines with other gases and soot particles to form a creosote-like material that hardens into a layer of tar on the flue wall. This is almost impossible to remove and is highly flammable. The build-up of acidic tars can corrode flexible metal liners, or even block them entirely.

If a chimney fire takes hold, the walls of the flue will become overheated and any timber embedded in, or closely adjacent to, the flue can begin to smoulder. This in turn can ignite the shavings and other dry debris lying between the floor joists, and the fire takes hold before its presence is discovered.

In addition to the above, other factors affecting fire risks in old buildings are as follows:

- **Nesting birds or squirrels.** A chimney stack or flue top can provide an inviting home to nesting birds or squirrels. This is particularly the case if a stone slab has been provided to stop rain from entering. Nests are often bone dry and will readily ignite. They partially block the flue and may cause combustion gases to divert via holes in the chimney to other parts of the building. Where nests completely block the top of a flue, the underside of the nest material may catch fire in the absence of oxygen, and convert the twigs etc to charcoal. As the nest steadily disintegrates, the smaller pieces of charcoal can be lifted on the updraught from a wood-burning stove. Once ejected from the chimney, they burst into flames in the presence of oxygen, and fall back like a Roman candle to land on the roof surface. Under trials, this scenario has been observed to cause thatch to catch fire. Always fit a reliable bird guard to prevent nests, but ensure it is cleaned regularly by an accredited sweep.

Figure 30: Chimney sweeping. Photo: © Douglas D Kent

Figure 31: Chimney height raised on thatched cottage. Photo: © Douglas D Kent

Figure 32: A chimney terminating less than the recommended 1.8 m above the ridge of a thatched building. The top of the terminal with an uninsulated pot is taken as being 150 mm above its base. The addition of a bird guard will reduce fire risk. Photo: Marianne Sühr

- **Defective parging to the walls of the flue.** Defective parging can cause smoke and sparks to reach timber more readily near, or in contact with, the flue.
- **Bends in the flue preventing sweeping, thereby allowing soot to accumulate.** If a sweep's brush cannot be inserted the full height of the flue due to abrupt or numerous bends, there is probably a latent fire risk due to the resultant accumulated pockets of soot.
- **Spark arrestors.** These fine mesh cages at the tops of pots or flues are intended to catch smouldering embers exiting chimneys on thatched buildings. It is now generally agreed that they clog up with tar deposits and other debris and actually increase the risk of fire due to the potential for this combustible material to catch light and then drop off onto the thatch. Spark arrestors should be removed at the earliest opportunity, particularly those in poor condition.
- **Insufficient separation between floor timbers and the hearth.** In old buildings, where a suspended floor meets the hearth to a working fireplace, either at ground or upper floor level, it is possible for the joist structure to catch fire. Any cracks in such a hearth are also potentially dangerous, as hot ash can work through the crack to timbers beneath. Where such an arrangement is present, check for risks and ensure fire cannot reach the timbers.
- **Sparks from open fires.** To prevent fire, install a fire guard and let fires die down before going to bed at night. Ideally, do not leave an open fire or stove unattended.
- **Failure to keep the chimney adequately swept (see 9.2 below).**

9.2 Chimney sweeping

The purpose of chimney sweeping is to help prevent chimney fires and reduce the risk of dangerous emissions from blocked flues. Chimneys in regular use should be swept at least twice a year when burning wood or bituminous house coal and at least once a year when burning smokeless fuels. The best time to sweep is just before the start of the heating season and, if sweeping twice a year, after the peak of the main heating period (see figure 30). Many building insurance policies require chimneys are swept at least once a year by an accredited chimney sweep and that an in-date chimney sweeping certificate be presented in the event of a claim.

Rods or brushes should be used, although tar from wood stoves may require scraping off first. Particular care is required with old chimneys to clean out hidden cavities from past alterations. It is important to employ a HETAS-registered chimney sweep.[34]

9.3 Fire in thatch

In recent decades, an average of 65 thatched houses have caught fire every year. The inappropriate installation, or irresponsible use, of wood-burning stoves are the most common causes.[35] Historic England and the National Society of Master Thatchers strongly advise against installing wood-burning or multi-fuel stoves in thatched properties.[36] Most stove-related fires occur during cold, dry spells of weather when thatch is most easily ignited. Such is the level of risk, there is now a general trend towards removal of wood-burning stoves in thatched cottages and the reinstatement of inglenook-type open fires.

If you are still considering fitting a wood-burning stove in a listed building, listed building consent is required. The presence of a wood-burning stove will need to be declared when seeking building insurance, otherwise may invalidate a claim. Before providing cover, the insurance company will require certification of correct installation from a HETAS-registered engineer or building control officer.[37]

Other chimney-related fires in thatch are caused by unsuitable fuel or kindling, the blocking of flues by birds' nests, and the ignition of tarry deposits due to the inadequate cleaning of flues, chimneys, spark arrestors or bird guards.

Deep multi-layered thatch increases fire risk by hiding defective chimney stacks and reducing the height of the stack above the roof surface. This provides a shorter distance for embers exiting the top of the stack to fall before coming into contact with the thatch. A stack terminating less than 1.8 m above the ridge of a thatched roof is more likely to cause a problem when combined with the following circumstances:

- Over-venting to wood-burning stoves (see box below).
- Nesting birds in the top of the flue.
- Burning lightweight/inappropriate material.
- Lack of user attention and knowledge.
- Absence of a stove thermometer.
- A spark arrestor, which can become clogged with tarry deposits that ignite and drop down onto the roof with the potential to cause a fire.

It is feasible sometimes to raise the height of the stack (which requires listed building consent) (see figure 31) but the additional weight of the masonry must not overload structural timbers. It may be appropriate to install a pot instead of, or as well as, increasing the chimney height. Bear in mind that the datum point from which the minimum stack height of 1.8 m is measured is taken from the flue outlet point where there is no pot, or 150 mm above the base of a pot where one is present (unless a wider pot with insulation is used (see figure 32)). Another option to consider is reducing excessive thicknesses of thatch. Advice should always be sought from the local authority conservation officer.

Chimney masonry is particularly prone to frost damage immediately below the roofline. Inspection here is, therefore, important with thatched buildings where a large portion of the stack may be concealed and makes an annual camera survey worthwhile. It is essential that chimney stacks are checked during patching/re-thatching work and any defects in bricks, stones or pointing remedied. If a chimney stack is unsafe it is advisable to display a 'do not use' notice on it and note this in the thatch record kept for the house.

Ignition and ventilation of wood-burning stoves

It is essential that the stove is attended during, and shortly after, lighting fires or refuelling when the risk of ignition of thatch is greatest. The controls should be readjusted to their normal 'safe' setting in line with appliance manufacturer's instructions immediately afterwards. Failure to do so may result in very high uncontrolled stove and flue temperatures coupled with elevated flue gas velocities. These factors may act to initiate chimney fires (if tar and soot are present). They may also lift burning material (embers) out of the chimney that could fall back to land on the thatch; or raise fires through gas escape under thatch if the masonry is imperfect and the chimney is unlined, or the lining is damaged.

9.4 Action plan in the event of a fire

Be sure to:

- Include the whole family in a regular fire drill. Have a plan of action in case there is a fire in the middle of the night. Plan escape routes and check windows can be opened quickly if escape is needed. Make sure children know what to do should they become separated from adults.
- Provide fire extinguishers and fire blankets in suitable positions and have them serviced regularly.
- Consult your local fire brigade over an action plan.

If a fire occurs:

- Evacuate the building.
- Call the fire brigade and make it clear if the building is thatched.
- Only if it is safe to do so, close all air inlets and dampeners on appliances and shut all doors and windows before leaving the building.

Figure 33: Structural instability. Photo: © Douglas D Kent

10 Chimney stacks and pots

10.1 Introduction

A chimney stack (or shaft) is the part of a chimney above the roof of a building. Regardless of the type of fireplace, chimney stacks are vulnerable structures. Their slender form is exposed on four sides and susceptible to wind and rain.

10.2 Structural stability

All chimney stacks are freestanding above roof level. Some, such as those found in timber-framed buildings, are really freestanding gravity structures all the way to the ground. Others are built into walls and do not exist as independent structures below roof level. A common problem when examining the structural stability of a chimney is the failure to diagnose whether the origin of the problem is in the ground or in the superstructure, and this is exacerbated by a failure to relate out-of-plumbness to the overall width of the chimney rather than to any wall into which it may be built.

Chimney stacks normally gain their stability by acting as gravity structures. This means that when the wind blows against the side of the chimney stack, the wind will try to overturn it, but the chimney is able to resist this effect due to its weight sitting across its base. A short stocky stack can resist larger wind loads than taller slender stacks.

A rule of thumb says that the height of the chimney stack, measured from the highest point of intersection with the roof surface, should not exceed four-and-a-half times the shortest horizontal dimension of the chimney. If it does, it could be prone to instability in very

Inspection of flues

Camera. A closed-circuit television (CCTV) camera, a specialised miniature camera, can be used to check the condition of a flue (including any parging or withes) and identify possible blockages, such as birds' nests or collapsed withes.

Smoke. Smoke matches are intended for use when only a small quantity of smoke is needed and are generally used prior to full spillage tests with smoke pellets (see section 4.6).

high winds. When pointing has dropped out of the masonry forming the stack, this effectively reduces the base and hence increases the slenderness. Higher winds are more likely in open country, at altitude (especially on exposed escarpments), and on the coast. Buildings in built-up areas and lowland districts tend to be more sheltered from the effects of high wind.

The wind has an immediate impact on a chimney stack. Chimneys, however, can also develop structural problems and lean over time due to a variety of other causes (see figure 33), including:

- Sulfate attack of mortar and/or masonry (especially at the top, where gases condense). The sulfate salts tend to be washed out of the side facing the prevailing weather and accumulate on the more protected side, causing expansion and curving of the stack, typically in a banana shape.
- Differential settlement within a building (where the structure moves at ground level), especially in the first few decades after the chimney was built.
- Embedded timbers within the chimney decaying.
- Corrosion and expansion of embedded iron cramps and lintels.
- Frost action on more vulnerable exposed parts of the chimney, leading to a breakdown of masonry and/or mortar (often at roof level or the cover flashing line) (see figure 34).
- Movement of the foundations. The effects are more general across the height of the chimney stack (and often in the surrounding walls too) and should be more visible at ground level as well.

It is important for the masonry of chimney stacks to be maintained in a reasonable condition and any pointing or larger sections of mortar which have dropped out should be repaired. Lime mortars are sensible in these repairs as they allow the masonry to 'breathe', but the mix used needs to be more durable than the lime mortars used generally for walling, given the more exposed position of chimney stacks and their inaccessibility.[38]

If there is any concern over the stability of a chimney stack, a structural engineer experienced in historic buildings should be consulted.[39] They will be able to establish the likely cause of the lean and, therefore, the potential for movement occurring in future. Provided the lean on the chimney is not severe, there are often sensible and sympathetic approaches that can be adopted, including tying or stitching the chimney to other parts of the structure. Rebuilding should always be considered the least desirable option.

10.3 Water ingress to chimneys and flues

Dampness in chimneys may be caused by rain ingress down open flues, rainwater penetration through the chimney walls or condensation within flues, for the following reasons:

- Entry of rainwater into flues because of the lack of chimney caps or rain guards. With old flues without a modern lining, such moisture is readily absorbed by the permeable lime parging in the upper part of the chimney and soon evaporated due to


34(a)


34(b)

Figure 34: A 17th-century stack viewed from the roof space **(a).** Note the erosion of the brickwork just below the roofline, causing the stack to become structurally unstable. **(b)** The same stack was repaired by a highly skilled bricklayer who propped it, opened up the roof and replaced the damaged bricks one by one. Photo: Marianne Sühr


35(a)
35(b)
35(c)

Figure 35: The repair of a damp chimney stack that had been coated in cement render: **(a)** After removing the render, new lead 'soakers' were inserted to prevent rain entering at the junction between roof and stack. **(b)** A continuous lead flashing was fixed to the brickwork, set into the lime mortar joints. **(c)** Finally the damaged brick was rendered with a lime mix. Photo: Marianne Sühr

the warmth of the flue gases. Modern metal flue liners, however, can act effectively as downpipes that convey rainwater down to hearths.

- Lack of a bend in a flue so that rain tracks straight from the outlet on to an open hearth below.
- Disintegration of the flaunching at the top of chimneys admitting rainwater.
- Rainwater penetration resulting from the inadequate thickness of flue walls (114 mm (4½ in) in the case of brick chimneys).
- Rainwater penetration due to the erosion of mortar joints and defective flashings or back gutters. Chimney stacks are thin-walled structures and, due to their exposed location, are vulnerable to wind-driven rain. Mortar pointing to stacks has a limited life, and once it starts to erode back, the dampness in a stack is exacerbated.
- Use on chimney stacks of inappropriate materials, such as cement mortars and renders (see figure 35).
- Disuse of chimneys, so that open flues and hot flue gases no longer help to keep them dry, for example, from moisture penetrating due to lack of damp-proof courses.
- Failure or lack of damp-proof courses where chimneys penetrate roofs. In stacks predating the mid-19th century, very few have damp-proof courses and, therefore, water often tracks down to saturate the masonry below rooflines, where evaporation and salt deposition cause decay. Unless a chimney must be rebuilt, absence of a damp-proof course has generally to be accepted.
- Condensation within redundant flues due to inadequate ventilation. Disused flues must be ventilated top and bottom.
- The presence of hygroscopic salts in masonry and plaster. These salts absorb moisture from the air in conditions of high humidity, and show up as damp patches on chimney breasts.

Emphasis should be placed on maintaining pointing and weatherings and keeping flues well-ventilated. Where possible, any vents should be installed on the least conspicuous face of a chimney. In view of the slenderness of the masonry, the problems cannot always be eliminated. However, the use of lime-based mortars for pointing and rendering (both internally and externally) can often reduce rainwater penetration by allowing the masonry to dry out more quickly.

10.4 Chimney pots and termination of flues

Loose chimney pots should be re-bedded in lime mortar and cracked pots on flues in use replaced. Chimney pots are often of smaller section than flues and in the past it was common for pots to be supported on iron bars set one or two brick courses down from the tops of chimney stacks. The gap between each pot and masonry would be covered with slate or tile with mortar flaunching placed over this around the pot. Corrosion of iron bars can cause cracking at the tops of stacks and lift the upper courses. If the bars corrode through, a pot can drop downwards.

Chimney pots of various forms can be used to reduce rainwater penetration. Careful selection of pots is essential to avoid spoiling the appearance of buildings. The warranties from some manufacturers require a rain cap over their liner to help prevent corrosion due to moisture ingress, though this is inadvisable in thatched properties because it can increase fire risk by causing embers to be ejected onto an ignitable roof below. Otherwise, a metal rain cap incorporating a bird guard can easily be fitted to the top of a pot, usually without affecting the draw. Caps can be powder-coated to match the colour of pots.

Water penetration down open flues can also usually be solved with a slab top, though these are inadvisable on thatched buildings (see figure 21).

Plant growth, including roots, should be removed from chimney stacks to prevent deterioration of the masonry. Redundant fittings and fixtures, such as television aerials, should be removed for the same reason.
A bird guard should be fitted to the top of any active chimney, especially if serving a thatched building. Sweeping alone will not mitigate the risk of twigs being introduced into the flue by nest-building birds. The device installed must not be capable of becoming blocked, obstruct the task of chimney sweeping or impair the chimney function.

10.5 Dampness staining to internal plasterwork

Damp patches on the inside faces of old chimneys are usually caused either by the poor structural condition of the stacks and adjoining roofs, which allows rainwater to soak into masonry, or by condensation penetrating through the walls of disused flues.

Once repairs such as the repointing of stacks have been carried out and flashings renewed, damp patches caused by rainwater should gradually disappear, although salts trapped in walls and plaster may continue to come to the surface for some time after the work has been carried out (once masonry has become saturated, it can take several months or even years before it thoroughly dries out).

If a flue in use is too cold, vapour will condense and lead to moisture contaminated with tar or acids either passing through the chimney walls or running down and leaking out around register plates. This can be a particular problem with wood-burning stoves where the advice to install an insulated liner has not been followed.

Brown staining on the internal face of an old chimney is generally caused by condensation inside a disused or rarely used flue. The moisture is absorbed by the masonry, carrying with it sooty tar deposits that then appear on the face of the plasterwork as an unattractive brown stain. Ventilating a disused stack will greatly alleviate this problem. Thorough sweeping, even of a redundant flue, may also help. While it should be recognised that plaster affected by staining in this way may be contaminated, its removal and replastering with a new lime plaster (after the wall has dried) should only be undertaken following an assessment of the significance of the existing plaster. This may bear evidence of old wall painting that is not always immediately apparent.

If stained plaster is renewed, a slurry of cow dung applied to the affected masonry prior to lime plastering often stops further staining, as with fireplace recesses (see figure 36). Alternatively, the new plaster can be separated from the masonry on chimney breasts using laths. These measures assume that the issues with dampness and tracking moisture have been addressed.

Figure 36: Using cow dung to prevent tar leaching in old chimneys: **(a)** Tar on bricks. **(b)** Two coats of fresh cow dung diluted to the consistency of ice cream are brushed on first, allowing thorough drying between them. **(c)** Manure is mixed into a scratch coat in a ratio of 3:9:1 lime: sand: manure. **(d)** The surface is worked, any cracks trowelled up with a wooden float as they appear and a key scratched when the coat is green hard. **(e)** A second lime coat and lime skin are applied as normal. **(f)** Finished inglenook with breathable paint.

Photos: © Yvonne Reynoldson

11 Redundant flues and stacks

Redundant chimney stacks should always be retained, even where fireplaces and flues are no longer in use. Chimney stacks contribute to the overall architectural form of buildings and provide evidence about their history. Additionally, they may be required in the future, if not for heating but for ventilation, service ducts or other uses not yet invented. Any decommissioning should, therefore, be reversible, allowing flues to be utilised or repurposed. The structural condition of stacks should continue to be monitored and maintained.

In the interests of energy efficiency, it is important to reduce air leakage from the internal environment via redundant flues. This can rapidly cool down interiors if left addressed. It is also essential, however, to continue to provide a degree of ventilation to a disused flue to minimise the risk of condensation and resulting damp patches and staining on internal walls, as well as deterioration of the structure. (See figures 37 and 38.)

For a short-term measure, or for flues used only occasionally, an inflatable ‘chimney balloon’, chimney umbrella or wool draught excluder can be inserted or, if present, damper closed. Scrunched up newspaper can also be inserted into chimneys to stop unwanted draughts.

Figure 37: Chimney termination: **(a)** The stack shown in figure 34 from above. Note the exposure to the weather and previous attempts at repair using cement-based mortars. **(b)** The top of the stack protected with new stone slabs. The two redundant flues have complete slabs, the working flue has a stone capping to the brickwork. **(c)** The redundant flues have air slots to prevent condensation. **(d)** The finished stack, repaired using hydraulic lime mortar. Photo: Marianne Sühr

For a longer-term solution, register plates can be fitted across the openings at the bottoms of flues. Such plates should incorporate insulation, to stop condensation forming on the undersides as warm heated air from rooms hits the otherwise cold surface. This solution should be designed to be reversible in the future, if the flues are ever brought back into use. Alternatively, fireplace openings could be blocked off and an airbrick, or other vent, inserted to the exterior if an outside chimney. For central flues that are not adjacent to an external wall, a vent can be fitted within the infilled fireplace opening.

If sealing a flue at the bottom, it is important to stop rainwater entering at the top. Any solution should allow ventilation at the head of the flue while also preventing birds from entering to nest. One way of achieving this is with a rain cap and bird guard. The chimney can be capped with a 'pepper pot' vent, if visually appropriate. For a capping that is largely invisible, the top of the pot can be fitted with a piece of slate, but this solution needs to incorporate a separate ventilation grille in the masonry stack just below the pot. For stacks without pots, a stone slab can be fitted, but raised slightly to incorporate ventilation slots. This has the additional benefit of deterring the growth of vegetation. An airbrick or other vent can be fitted to the side of the stack if the top has been concreted over.

Exclude bees from nesting in disused chimneys with fine stainless steel mesh or a cap which incorporates an integral insect grille.

Figure 38: A redundant flue should be ventilated at the bottom where the fireplace opening is blocked off.
Photo: © Douglas D Kent

12 References

1 See https://www.spab.org.uk/advice/glossary

2 The provision of a louvre (from the French *l'ouvert* or opening) above a central hearth allowed for the escape of smoke. Clues for these are sometimes found in the seatings located on rafters within the roof structure. Louvres were also sometimes located in a gable or gablet

3 Such as at Stokesay Castle, Shropshire (13th century); Penshurst Place, Kent (c1341); and Bayleaf, Weald and Downland Living Museum, West Sussex (dendrochronologically dated to 1405-1430)

4 Fine surviving high-status examples can be seen in the stone-built kitchens for Glastonbury Abbey, Somerset and Harcourt House at Stanton Harcourt, Oxfordshire. Vernacular timber-framed examples have been well-documented by David and Barbara Martin in Sussex, dating from about 1450 to 1550, and other examples are known in Oxfordshire, including at Russet's Roke (dendrochronologically dated to 1468) and Willoughby House, Dorchester-on-Thames (c1550s)

5 According to Salzman, 1952

6 Wiliams, 2010

7 The wall fireplace at Rochester Castle, Kent (c1130) was of semi-circular plan and had a semi-circular arched head with chevron moulding; at Boothby Pagnell Manor House, Lincolnshire (1180), the stone hood has a joggled lintel carried on corbels. Other early examples of stone hoods are found at Stokesay Castle, Shropshire (c1240), Abingdon Abbey, Oxfordshire (late 13th century), and Ham Court, original gatehouse to Bampton Castle, Oxfordshire (c1315). The stone hood at Abingdon would have been of similar form to that of The Old Deanery, Lincoln (early 14th century). A fireplace with lintel of double-shouldered form is found in the solar undercroft of Charney Bassett Manor, Oxfordshire (c1280)

8 Examples of 15th-century fireplaces can be found in Abingdon, Oxfordshire at The Long Gallery (c1455) and 26a East St Helen's Street (late 15th century with a rare arcaded frieze)

9 Framlingham Castle, Suffolk (c1150-1160), Sutton Courtenay Abbey, Oxfordshire (13th century)

10 As seen at the Château de Sully in the Loire Valley

11 As at the Checker, Abingdon Abbey, Oxfordshire (c1260); there is also a notable lantern form of chimney at Kingham in the same county and several in Somerset

12 Examples are known from County Antrim; and Don Farm, St John, Jersey (dated 1673 with joggled stone lintel supported by sturdy stone piers and corbels, reminiscent of 12th-century Norman examples)

13 Clifton-Taylor, 1987

14 For example, Batemans at Burwash, East Sussex

15 Harrison, 1994, p201

16 A fireplace for baking survives at Little Castle bakery, Bolsover Castle (c1617); and examples for brewing at Chastleton and Fletcher's House, Oxfordshire (17th/18th centuries)

17 Pattern books proliferated – see Ware, 1767 and Gibbs, 1728

18 Such as Richard Neve's *The City and County Purchaser* (1703) and Peter Nicholson's *The New Practical Builder, and Workman's Companion* (1823)

19 Cave, 1981, p119

20 Clifton Taylor, 1987

21 Early 17th-century fireplaces in the stone area of the Banbury region were noted by Wood-Jones (1963) as stone-built of circular plan, contained wholly within the space to the side of a stack or, from c1650, could be contained in a bread oven projection or 'bulge' on the exterior, which would often be roofed corresponding to the main dwelling in thatch or stone slate. Through the 18th century, these projections increased in size and height to project far beyond the walls. Early examples in the Banbury area were semi-circular in plan, later rectangular, opening off the back of the fire not the reveal, presumably to leave room for ingle seats of square or semi-circular plan. The opening into the oven from the hearth was noted as usually being about 2 ft wide by 18 in high (600 x 450 mm) with a removable or hinged iron door, the base of the oven flat, many later re-surfaced with brick. Plot's *Natural History of Oxfordshire*, first published in 1677, mentions Taynton stone set edgeways as making the best hearths for ovens

22 Slocombe, 1992 suggests that prefabricated clay or cloam ovens were the answer where stone or brick was not readily available. Cloam ovens were made from the 17th century to the early 20th century in the Barnstaple area of north Devon and could be found further afield in Gloucestershire and Wiltshire, and were even exported to South Wales and North America. They were bought as a complete unit and could be built into the fireplace or used on the hearth

23 For more about mortar mixes suitable for old buildings, see SPAB Technical Advice Note on: *Repointing Stone and Brick Walling*

24 For further advice on asbestos, see http://www.hse.gov.uk/pubns/guidance/em1.pdf

25 Such engineers will have either undergone the SPAB Scholarship programme or be listed on the Conservation Accreditation Register for Engineers (CARE) maintained by the Institution of Civil Engineers and Institution of Structural Engineers

26 The test procedures to be followed are described at https://www.hetas.co.uk/commissioning-guidance-smoke-spillage-flue-draught-testing/

27 McDonald, 1984, p41

28 Kholucy, 2013

29 See https://historicengland.org.uk/content/docs/advice/fpa-fire-thatched-properties-leaflet-2018pdf/

30 Anon, no date

31 Look out for retail bags of wood fuel clearly labelled as 'Ready to Burn' by a Woodsure-certified supplier when purchasing firewood for immediate use. This helps consumers distinguish wood that is ready-to-burn (less than 20% moisture content) from wet wood requiring further seasoning before being burnt. See www.woodsure.co.uk

32 See https://smokecontrol.defra.gov.uk/fuels.php

33 Statistics on chimney fires in England for 2017/18 provided to the SPAB by HETAS give the following seasonal breakdown: April to June 16.7%, July to September 5.7%, October to December 31.9%, and January to March 45.7%

34 It is recommended that chimney sweeping be undertaken by a HETAS-registered chimney sweep. Chimney sweeps register either via their membership of one of four trade associations recognised by HETAS or, where an individual is not with one of these bodies, through a direct entry scheme. The associations recognised by HETAS are: Association of Professional and Independent Chimney Sweeps (APICS), Guild of Master Chimney Sweeps, National Association of Chimney Sweeps (NACS) and Sweep Safe. The names of HETAS-registered chimney sweeps can be obtained from HETAS at: https://www.hetas.co.uk/find-chimney-sweep/

35 National Society of Master Thatchers, 2017

36 See https://historicengland.org.uk/content/docs/advice/fpa-fire-thatched-properties-leaflet-2018pdf/ and https://www.nsmtltd.co.uk/wp-content/uploads/2019/01/3.-Fire-Prevention-in-Thatched-Properties-Advice-Notes-to-Download.pdf

37 See HETAS Technical Note TN_007 v2 on *Chimneys in Thatched Properties: HETAS Installation Guidelines and Advice*

38 For more about mortar mixes suitable for old buildings, see SPAB Technical Advice Note on: *Repointing Stone and Brick Walling*

39 The SPAB can advise on the names of structural engineers experienced in dealing with old chimneys

13 Other advice

13.1 Contacts

Where work to chimneys is being considered, the SPAB may be able to suggest suitable specialists.

13.2 Other organisations

- **Association of Professional and Independent Chimney Sweeps**
  www.apics.org.uk
  0345 604 4327
- **British Flue and Chimney Manufacturers' Association**
  www.bfcma.co.uk
  0118 940 3416
- **Fire Protection Association**
  www.thefpa.co.uk
  01608 812500
- **Guild of Master Chimney Sweeps**
  www.guildofmasterchimneysweeps.co.uk
- **HETAS Ltd**
  www.hetas.co.uk
  01684 278170
- **Historic England**
  https://historicengland.org.uk
  0370 333 0607
- **National Association of Chimney Sweeps (NACS)**
  https://nacs.org.uk
  01785 336555
- **National Society of Master Thatchers Ltd**
  https://nsmtltd.co.uk
  01530 222954
- **Solid Fuel Association**
  https://solidfuel.co.uk
  01773 835400
- **Sweep Safe**
  www.sweepsafe.com
  01803 390087
- **Weald & Downland Living Museum**
  www.wealddown.co.uk
  01243 811363
- **Woodsure**
  https://woodsure.co.uk
  01684 278188

13.3 Further reading

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13.4 Advice from fire and rescue authorities

Many UK fire and rescue authorities offer advice on fire safety. Links to the websites of the individual authorities can be found at: https://www.nationalfirechiefs.org.uk/Fire-and-Rescue-Services .

Appendix A

Options for relining flues

Missing areas of parging should be renewed wherever possible using a traditional lime-based mix but in certain circumstances the use of alternative, modern lining systems may need to be considered to improve the safety or efficiency of flues (see section 6). This appendix sets out the main options available when installing a modern lining system and the implications of each for old buildings.

Lining method	Description	Issues in old buildings
Rigid metal liners	Rigid metal (usually high-grade stainless steel) pipes lowered in sections from chimney tops. There are two types: • Rigid single-skin sectional liners. • Rigid twin-wall sectional liners with insulation.	• Rigid twin-wall liners, in particular, can be a good way of relining flues in old buildings. The rigidity of such liners, however, usually means that they are best suited for straight flues (though pre-made adjustable bends are available). • The spaces around single-skin liners should generally be insulated in the same way as with flexible stainless steel liners (see below). • Twin-wall liners in thatched properties require back ventilation. • Reversible, and have limited structural loading implications. • Must be supported at intervals. • Can expand by approximately 30 mm over 8.0 m and, therefore, need to be firmly anchored at the bases of chimneys but not fixed where passing through closing plates at the tops to allow for movement. • Reduce existing flue cross-sections less than sectional solid liners and poured systems. • Acid attack can limit their lifespan with certain processed solid fuels so regular inspections are advisable.
Flexible stainless steel liners	Flexible metal liners in continuous lengths, either lowered down (more usual) or pulled up flues. They are usually hung from clamps or plates mounted at the tops of chimneys and similarly clamped at the bases, prior to forming connections to appliances or heat sources. A small ventilation hole (minimum of 20 mm) should be inserted at the top of a stack to allow any moisture trapped in the old flue to escape. Manufacturers' installation instructions should generally be followed, but if there is felt to be a conflict with historic fabric this should be fully investigated. There are two distinct types of liner available: 1. Gas flue liners: Light-gauge single-skin liners suitable only for closed gas fires and boilers and for some inset live fuel effect gas fires. They must never be used with solid fuel or wood-burning appliances or open solid fuel effect gas fires 2. Solid fuel liners: Double-skinned liners made from titanium austenitic grade stainless steel. Usually smooth on the inside and corrugated on the outside. Suited particularly for stoves and other appliances with closed or glass fronts.	• Pass round most bends without the need to open up flues, hence are often suitable where rigid metal liners are unviable. • Reversible, and with limited structural loading implications. • Spaces around liners should be backfilled with loose fill insulating material, such as vermiculite, that is 'breathable' but not hydrophilic. The insulation will keep flues warm and reduce tar build up (which is a particular concern with wood-burning stoves). Some manufacturer's provide insulation specifically designed for inglenooks where backfilling with loose fill could be impractical. (**Note:** Fibreglass insulation should not be used for solid fuels.) • Relatively cheap and easy to install. • The flexible construction takes up the expansion of the metal. • Care should be taken to ensure these flues are installed the correct way up and swept with flexible brushes (usually polypropylene with a plastic ball top top) as they are easily damaged. • Same corrosion issues with solid fuel as for rigid metal liners, so sometimes have short lifespans.

Lining method	Description	Issues in old buildings
Sectional solid liners	Rigid refractory concrete, clay, ceramic or pumice sections installed by cutting into flue walls or by lowering from the tops of chimneys.	• Chimneys need opening at frequent intervals to install the sections, including every bend, and this disturbs masonry and finishes. Therefore, usually an option only when the flue is straight and large and the inserted sections can be lowered from the top without opening the flue inside the building, unless an old chimney is being extensively rebuilt for other reasons. • Difficult to reverse once installed. • A reduction in flue cross-section may limit the type of fire or appliance that can be used: the wall thickness of the liner is 20-25 mm and with the tolerance required for installation, this may mean that open fires cannot be used and a closed appliance has to be fitted. A nominal 225 x 225 mm (9 in x 9 in) flue is usually reduced to 150 x 150 mm (6 in x 6 in). • When the sections are jointed with rebated and socketed joints (as opposed to steel jointing band system) they must be installed the correct way up to prevent condensates running down the flue. • Once installed they are hard-wearing and have a long life.
Thermosetting resin liners	Flexible impermeable skins (rather like firemen's hoses) that are pulled up chimneys or down from the tops, heated and expanded under pressure to form thin, close contact coatings against the existing flue surfaces. The type of thermosetting resin used varies depending on the nature of the fuel source for the fire.	• Accommodates bends and does not reduce flue diameter significantly. • Problems can arise when wind-driven rain passes through the masonry of exposed stacks and becomes trapped at the interface between an impermeable lining and old inner face of a flue. This can lead to frost damage due to saturation of the masonry, as well as water ingress trickling down into the upper rooms where the two materials meet. • While many of these systems are not physically adhered to the flue, and are, therefore, technically reversible, they are difficult, if not impossible, to remove where access to the flue is limited. • Concerns exist about what would happen to such linings during chimney fires. • Limited structural loading implications. • Moulded to take the existing shapes of flues, which maximises the cross-sectional areas. • Good corrosion-resistance and lifespan.
Spray-on and ceramic lining systems	Impermeable flue lining coating materials applied by passing revolving spray heads slowly through old flues. A variation involves applying a thin ceramic coating, using an inflated plug that is drawn up through flues.	• Accommodates bends and does not reduce flue diameter significantly. • Problems can arise when wind-driven rain passes through the masonry of exposed stacks and becomes trapped at the interface between an impermeable lining and old inner face of a flue. This can lead to frost damage due to saturation of the masonry. • Difficult to reverse. • Some proprietary systems involve coring out the interior of the flue to ensure that a clean uniform surface is formed prior to relining. This is destructive and irreversible. • Limited loading implications. • Constituents and deterioration mechanisms of the lining material vary and need to be confirmed as some may have deleterious effects upon historic fabric. Future development could include use of a traditional lime-based parging mix. • Masonry must be largely intact and reasonably robust, as there is risk otherwise that fragile sections could be dislodged. • Insufficient thickness on the outside of bends may be a problem. • Lifespan is variable.
Cast *in situ* (pumped) concrete	Insulating lightweight concrete is pumped in around an inflatable rubber former or 'sausage'. The former is located by spacers, usually placed every 2 m and at all bends, and inflated to the required flue size prior to pumping in the concrete.	• Many potential problems when installed in historic buildings, so generally inappropriate. • Largely irreversible once inserted. • Spacers are required to be inserted to locate the former and this disturbs masonry and finishes. • While light aggregate is used there are still loading implications in often fragile historic structures. Localised rigidity may also cause problems in adjacent materials subject to a degree of movement.

Lining method	Description	Issues in old buildings
Cast *in situ* (pumped) concrete, cont'd	Once the concrete has set, the former is deflated and removed.	• Not suitable for the very large voids found in the lower sections of inglenook chimneys. • Impermeability can be detrimental and moisture in the concrete may mobilise damaging sulfates. • May reduce flue cross-section with implications as detailed for rigid refractory liners. • Distortion of the rubber former at bends can result in constrictions and variable wall thickness of the lining with consequent problems of localised 'hotspots'. • Defects in masonry or withes can result in loss of the concrete into voids or adjacent flues. • Once installed they have a long life.

Table A1: Options for relining flues where not re-parged and the implications for old buildings

The content of this advice note is offered in good faith, but neither the author nor the Society can accept responsibility arising from any incorrect or incomplete information that may be included. The use of traditional materials may incur risks different from those associated with modern materials. Manufacturers' and suppliers' guidelines should always be observed. This document should be seen as a contribution to a continuing debate and we welcome comments.

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