



ENGLISH HERITAGE

ENERGY EFFICIENCY IN HISTORIC BUILDINGS

Open fires, chimneys and flues

This guidance note is one of a series which explain ways of improving the energy efficiency of roofs, walls and floors in historic buildings. The full range of guidance is available from the English Heritage website:

www.climatechangeandyourhome.org.uk

Content

Introduction	03
Developments in chimney design	04
Chimneys in use	05
Disused flues	12
Further information	16
English Heritage National Offices	19

Introduction

This guidance note provides advice on how unused or intermittently used chimneys can be made more energy efficient by preventing draughts. Open chimneys and flues can be sources of useful ventilation but they can often let too much warm air out and cold air in. The resultant draughts can create uncomfortable conditions.

Guidance is also included on the use of open fires and wood burning stoves. The burning of firewood grown in local well managed forests is an excellent sustainable source of heat with only incidental carbon dioxide emissions from planting, felling, cutting, drying and transport. In rural areas this presents a good way to reduce the overall carbon dioxide emissions from a building.

Chimneys in older buildings can develop a wide range of defects. This guidance note discusses how to avoid introducing further defects when measures are taken to improve energy efficiency. It does not discuss the diagnosis or remedy of existing defects.

Chimneys are often prominent and significant parts of historic buildings. Fireplaces are frequently striking and important elements of the interior. Many chimneys were constructed in single skin brickwork and are very sensitive to alteration. Great care should be taken and specialist advice sought, before adapting or altering a chimney.

Fireplaces and chimneys are often still in use, some for open fires, some for room heating stoves, and some for central heating and hot water boilers. Many other fireplaces and chimneys are no longer needed and have been blocked up, temporarily or permanently. Whether used or unused, fireplaces and chimneys can have an important role in improving the energy efficiency of a building.

Developments in chimney design

Chimneys were not widely used in domestic buildings until brick became available in the late medieval period. Before this, most dwellings used open hearths, with one large fire, typically in the centre of the building, for both heating and cooking. The smoke would billow around the inside of the building before escaping through gaps or simple louvres in the roof.

Some early chimneys were constructed of timber framing with wattle and daub infill and are known as 'smoke hoods'. If they are found in-situ or even in use they are important and rare survivals of historic fabric and should be conserved. Smoke hoods are sometimes unrecognised because a later chimney with fireplace has been inserted at low level and a brick or stone stack added above the roof.

The earliest brick chimneys were built over traditional open hearths. Wood consumption was high, as most of the heat went up the chimney with the smoke, while cold air was sucked in from the outside through the leaky building fabric.

As comfort standards improved and buildings became more compartmentalised, smaller fireplaces were required in more parts of the building. This trend was aided by the growing availability of coal in the 17th and 18th centuries, especially in urban areas. Coal burns more efficiently than wood, providing more heat from a smaller fire. Coal fires benefit from being in a grate that allows more oxygen to reach the burning coal.

In the 18th century the writings of Count Rumford, founder of the Royal Institution in London, greatly influenced the basic design principles of chimneys and fireplaces. A similar wish for improved efficiency provided the impetus for filling in many earlier inglenook fireplaces.

As fireplaces became smaller and more efficient, so did chimneys. In the 18th and 19th centuries they became more and more complex, often combining several flues, each serving a separate fire.

The divider between flues within one chimneystack is called a withe. Withes were often slender, sometimes a single thickness of brick laid on edge, sometimes thin cut stones or occasionally a single layer of slate. This makes them vulnerable to damage when a chimney is swept, particularly at bends and other complex flue configurations.

Most brick flues are lined to prevent gases escaping through joints and cracks. The traditional method of lining chimney flues was to apply a mix of lime putty and fresh cow dung, known as 'parge' as the chimney was built. Parging continued to be common until the 1965 Building Regulations introduced a requirement for all new flues to be built with a liner during construction. During the 1960s the most commonly used flue liner was clay pipes, though with further tightening of the regulations concrete and metallic flue liners took over.

Chimney pots did not come into common use until the 17th century and early 18th century. Most pots seen today are 19th century or later.

The fabric of chimneys in historic buildings and debris that accumulates in disused chimneys can be of archaeological importance. Care should be taken not to lose historic fabric during the opening up of old flues or during the process of making alterations to flues in historic buildings. Listed Building Consent may also be required.

Chimneys in use

BUILDING REGULATIONS

Any installation of a heating appliance, or modification to a chimney such as re-lining, has to be carried out in accordance with the Building Regulations – *Approved Document J* which gives detailed advice on these types of work. There is also a requirement that Building Control consent is obtained unless the work is carried out by someone registered with a ‘competent person’s scheme’.

‘Competent persons’ currently are those who are registered members of the following organisations:

- The Heating Equipment Testing and Approval Scheme (HETAS) for solid fuel and wood burning appliances
- The Council for Registered Gas Installers (CORGI) for gas burning appliances
- The Oil Firing Technical Association for the Petroleum Industry (OFTEC) for oil-fired appliances
- The National Association of Chimney Sweeps (NACS)
- The National Association of Chimney Engineers (NACE)

RE-USING OLD CHIMNEYS

It may be possible to re-use an old chimney for solid fuel, oil or gas fires or stoves, depending on the desired aesthetic and functional requirements and the nature and condition of the chimney. Whatever fuel is used the installation should be carried out in accordance with Building Regulations and British or European Standards appropriate for the appliance selected. It is essential to establish that the chimney is safe to use.

Before returning an old chimney to use, its condition should be checked thoroughly, including that of any withes. If a visual examination is not possible the use of a boroscope or CCTV should be considered. Even if the flue is to be lined, ensure that any necessary repairs are made before the liner is inserted. Finally the chimney should be tested according to the fuel used.

If there are any concerns about the structural integrity or water-tightness of a chimney, a structural engineer, surveyor or architect should be retained to investigate. The disturbance caused by the insertion of a flue liner and the stresses caused by the heating and cooling cycles can exacerbate any

existing problems. A survey is particularly important if the chimney is to be reused for an open fire without a lining; the stack will be subject to greater heating and cooling cycles and to chemical attack from compounds in the smoke.

SMOKE TEST PROCEDURE (from BS 6461: part 1)

If there is an appliance fitted at the base of the bottom of the chimney burn some newspaper in the fire/grate for 2/3 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 temperatures or volume of hot gases that would normally be created whilst a heat generating source is in use but this 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 pellet manufacturer's safety instructions.

Ignite the pellets and when they start smoking seal the opening with a board or plate sealed at the edges or if an appliance is fitted, close all doors, ashpit covers and vents.

When smoke begins rising out of the top of the chimney, seal the top of the flue, terminal or pot (use an inflated football bladder or plastic bag sealed in position with tape).

Examine the full length of the chimney for any leakage of smoke (include, where relevant, any cavities at the back or around the chimney, 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).

For gas fired appliances BS 5440-1 contains a flue flow and spillage test.

Any fossil fuel-fired fire or stove, new or existing, needs ventilation to feed combustion. Check carefully as draught-proofing measures and other works may have reduced the air supply available for the fire. With insufficient ventilation, the chimney may not 'draw' properly, and smoke, and/or invisible, odourless carbon monoxide, may spill out into the room. Carbon monoxide detectors may be installed to warn against the build up of this toxic gas but care is needed to position and maintain them –consult the manufacturer's instructions or seek expert advice.

In some properties, large fireplaces have been partially blocked to install smaller, more efficient, ones. There is often a desire to open up the fireplace, particularly where large 'inglenooks' may be present. Before doing such works an assessment should be made of the historical value of later insertions or alterations. For listed buildings the local authority conservation officer should be consulted, as consent is likely to be required. Take care when exposing an early fireplace as it is easy to destroy historic detail, such as decorative paint schemes.

Large fireplaces often have chimneys which are too large for modern needs. If so, a register plate can be installed- to reduce the size of opening at the base of the chimney flue. This normally a horizontal, fireproof (metallic) plate

with a central opening to allow the fire to be used, and to which a flue liner can be connected above. Sometimes a hood is attached to the underside of the register plate to guide smoke from a large fire into the flue. Register plates above open fires (other than gas effect fires) should be provided with dampers (see below). Disused fireplaces may be fitted with a register plate with no opening, or with small holes to provide any necessary ventilation.

OPEN FIRES

Open solid fuel fires are the most traditional method to heat old buildings, but they are much less efficient than a solid fuel stove. Whilst open fires tend to produce lower flue gas temperatures, liners are advisable to safely conduct the flue gases to outside. Liners are essential for chimneys in poor or uncertain condition, or if there are problems of contamination in the flue.

Solid fuel open fires use three main types of fuel:

- Wood
- Bituminous house coal
- Smokeless fuels (either natural anthracites or manufactured smokeless brickettes)

SMOKE CONTROL LEGISLATION

The Clean Air Act of 1956 gave local authorities the ability to declare smoke control areas. In those areas it is an offence to emit any smoke from a domestic chimney, except for the very small amounts from burning authorised 'smokeless' fuels.

There is an exemption for appliances approved as being able to burn bituminous coal and/or wood without creating smoke.

For further information about:

- smoke control legislation
- smoke control areas
- authorised fuels, and
- exempted appliances

or to check whether a particular building is within a smoke control area contact the local authority or visit www.uksmokecontrolareas.co.uk.

Wood has the lowest carbon emissions of the fuels but burns least efficiently and is not suitable for use in smoke control areas (unless used in a stove that has an exemption). House coal is inexpensive but is also unsuitable for use in smoke control areas. Smokeless fuels can be burned in any location and burn more efficiently than either house coal or wood.

Logs are the most common form of wood fuel for open fires. These will usually come from local sources and can be bought from a variety of outlets

–coal merchants, farmers and timber yards. Logs need to be dry and seasoned for at least one year or more for certain timbers. Wet or unseasoned wood not only burns less efficiently, but can cause a harmful build up of deposits in the chimney in a very short time. The resulting thick coatings of creosote or resinous material can cause chimney fires, prevent the chimney functioning properly and introduce contaminants that can seep through the walls and discolour decorations.

TYPES OF FIREWOOD

Historically the knowledge of timbers for fires was well known and a number of well known 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.

Chesnut 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 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.

Open fires may be simulated by decorative fuel effect gas fires. These remove the need to buy and store wood or coals etc but they do require a

gas supply, typically from either from a natural gas mains supply or a local LPG (liquid petroleum gas) tank or bottle. They are also very inefficient – typically 20 per cent to 40 per cent efficient, compared to 90 per cent efficiency for a condensing gas boiler.

DAMPERS

A chimney for an open fire will be a cause significant draughts when it is not in use. A good remedy for this is to fit a damper, which can be installed either in the throat of the chimney, the flue, or at the top of the chimney. The best types are easily opened and closed using a handle that also indicates the position of the damper flap. Dampers should not block all the air entering the chimney as a small permanent flow is necessary to ventilate the flue when it is not in use. If a gas appliance is to be used, any damper must be fixed in the permanently open position.

FLUE SIZING

The smallest recommended flue size for a open flue solid fuel fire with an opening of 500mm x 500mm is a round flue of 200mm diameter, or rectangular with an equivalent cross section. This may have to be increased if the chimney is less than 5 metres high or if there are bends in the flue. For a larger open fire the cross section area of the flue should be at least 15% of area of the fire opening (width x height). Details of flue sizing for all fuels are given in the Building Regulations *Approved Document J*.

ROOM HEATERS AND STOVES

A 'room heater', an enclosed appliance in which fuels are burnt, can be a suitable alternative to an open fire in traditional buildings. A wide range of designs are available. They burn fuel much more efficiently than open fires and cause fewer draughts. Often they can burn wood: logs, scraps, chips and pellets, which can help to reduce carbon dioxide emissions. Gas fired versions are also available.

Heat radiates from the casing and through a glass front and by convection from air passing around or through the appliance. Some room heaters are recessed or semi-recessed into a wall, often in an existing fireplace; others are freestanding away from the wall. Some recessed models have back boilers which can supply hot water or central heating. Freestanding stoves are types of room heater. Certain room heaters are certified as being able to burn wood and coal without creating smoke, allowing wood to be burned in smoke control areas.

Room heaters or stoves must be installed by a 'competent person', i.e. an engineer registered with HETAS for solid fuel, OFTEC for oil or CORGI for gas. The flue gas temperatures from a room heater can be significantly more than from an open fire so care is needed to reduce the risk of fire or heat damage. A flue liner will always be required; and if a flexible metal liner is used it must be double skinned. Some chimneys may not be capable of

accommodating an adequate liner and so will be unsuitable for a room heater.

BOILERS

An old chimney is often a good place to run the flue from a new energy efficient boiler fired by solid fuel, oil or gas. However, some modern boilers have relatively cool exhaust gases that may not be able to rise up some chimneys, particularly tall ones. Such boilers are now available with flues that can vent the exhaust gases horizontally through the wall of the building. Sometimes these flues can be run for a short distance up a disused chimney before venting to the outside in a more convenient and perhaps less conspicuous position.

Fitting a boiler to an existing flue will normally require the insertion of a flue liner. It is important that this should be selected and installed by a competent certified professional to the standards set out in the European Standards for flues. Typically a flexible corrosion-resistant metal liner is lowered down the flue in a continuous length.

FITTING FLUE LINERS

Not all chimneys are capable of accepting a new flue liner. Flues in traditional buildings are sometimes narrow, contorted or distorted by structural movement over the years. Attempting to force a flexible metal flue liner down such chimneys will not always be successful and risks damaging historic fabric. Flexible metal liners also do not have a long life and will need to be inspected and replaced when necessary. The space between the original flue and the new flue liner should be ventilated top and bottom. Flue liners that require backfilling between the liner and the chimney should be avoided in traditional buildings.

SWEEPING CHIMNEYS

Chimneys in use should be swept regularly. This will help reduce the risk of poisonous gases spilling into occupied rooms, help prevent chimney fires and enhance the operation of the flue. The National Association of Chimney Sweeps recommends the following:

- Smokeless Fuels At least once a year
- Bituminous Coal At least twice a year
- Wood Quarterly (when in use)
- Oil Once a year
- Gas Once a year

All gas appliances, including the flues, should be checked for safety at least every twelve months by a CORGI-registered installer. It is a legal

requirement that landlords must have all gas appliances and flues checked annually.

THATCH

Great care is required when using combustion appliances and chimneys in thatched buildings. If in any doubt, consult the local fire prevention officer.

The risks of the thatch catching fire can be minimised with careful maintenance. Evidence from the Hampshire Fire and Rescue Service suggests that 90 per cent of thatch fires are caused by faults in the flue or chimney, not by flying sparks. The National Society of Master Thatchers believes that a major cause of fire in thatched buildings is the build up of thatch to thicknesses in excess of one metre as a result of repeated over-thatching. This provides better insulation to the chimney and can raise the temperature of the thatch near the chimney to levels at which fires can ignite. This risk is greatest in chimneys positioned centrally in the roof, and is exacerbated by the use of multi-fuel stoves with very hot flue gasses, and inappropriate flue liners. The most important fire preventing measures are therefore to:

- avoid excessive build up of thatch thickness around chimneys in use
- be especially cautious about installing multi-fuel stoves in thatched buildings,
- ensure that the pointing and brickwork of the chimney stack are in good condition (repairs are most easily carried out during re-thatching),
- fit flue liners
- sweep chimneys frequently.

Spark arresters at the top of chimneys can provide some extra protection, but only if they are cleaned and maintained regularly. If maintenance is neglected, as it often is, the spark arrester may itself add to the risk.

For information about improving the energy efficiency of thatched buildings see the guidance note *Insulating Thatched Roofs* in this series.

Disused flues

ALTERNATIVES FOR DISUSED FLUES

Traditional buildings need ventilation to help the fabric 'breathe'. When in use, the chimney and the fire beneath would have contributed greatly to the ventilation rate, so it is sometimes thought that chimneys need to be left open to allow continuing ventilation. In most traditional buildings the sources of air for combustion, plus other gaps in the fabric, are sufficient for the interior fabric to perform properly. A disused flue, if left fully open, will often add unnecessarily to draughts and heat loss. If uncapped, it can also let water in, leading to damp and staining. If the building is thought to be particularly airtight, perhaps shown by condensation or mould growth in other rooms, then a fan pressurisation test can be used to determine to what extent the flue should be left open.

MAINTAINING BREATHABILITY WHEN MAKING IMPROVEMENTS

Most traditional buildings are made of permeable materials and do not incorporate the barriers to external moisture (cavities, rain-screens, damp-proof courses, vapour barriers and membranes) which are standard in modern construction. As a result, the permeable fabric in historic structures tends to absorb more moisture, which is then released by internal and external evaporation. When traditional buildings are working as they were designed to the evaporation will keep dampness levels in the building fabric below the levels at which decay can start to develop. This is often referred to as a 'breathing' building.

If properly maintained a 'breathing' building has definite advantages over a modern impermeable building. Permeable materials such as lime and/or earth based mortars, renders, plasters and limewash act as a buffer for environmental moisture, absorbing it from the air when humidity is high, and releasing it when the air is dry. Modern construction relies on mechanical extraction to remove water vapour formed by the activities of occupants.

As traditional buildings need to 'breathe' the use of vapour barriers and many materials commonly found in modern buildings must be avoided when making improvements to improve energy efficiency, as these materials can trap and hold moisture and create problems for the building. The use of modern materials needs to be based upon an informed analysis where the implications of their inclusion and the risk of problems are fully understood.

It is also imperative that buildings are well maintained, otherwise improvements made in energy efficiency will be negated by the problems associated with water ingress and/or excessive draughts.

A disused flue still needs some residual ventilation to help keep it dry. Chimneys are prone to water penetration, being very exposed to the

weather, and often having thin brick skins. Combustion by-product deposits in the flue can also take water out of the air and not only dampen the fabric but lead to unsightly staining on interior decorations.

DAMPNESS IN CHIMNEYS

Dampness in chimneys may be caused by water penetration down open flues, water penetration through the walls of the chimney or as a result of condensation within blocked or partly blocked flues.

Chimneys tend to have slender walls which make them vulnerable to water penetration in exposed locations. Particularly vulnerable are side stacks and chimneys with offsets.

Water penetration may also be attributable to the deterioration of the fabric (cracks, worn pointing), the lack of effective flaunching or a damp proof barrier, or the use of inappropriate materials (cement based pointing or renders)

In view of the slenderness of the masonry the problems cannot always be eliminated. However, using lime based mortars for pointing and rendering (both internally and externally) can significantly reduce the impact of water penetration.

Chimneys are particularly prone to deterioration in the area immediately at and below the level of the roof covering. This may occur as a result of moisture within the upper exposed part of the stack being drawn down towards the protected (drier) area and evaporating, causing salt deposition and deterioration of the upper part of the protected section of chimney. It is therefore important to regularly inspect this part of the chimney. In thatched buildings, the area concealed can be large, so it is essential to check chimney stacks during patching/re-thatching work and to remedy any defects in brickwork, masonry and pointing.

Staining on the internal face of an old chimney is usually caused by condensation inside disused or rarely used flues that are inadequately ventilated. The moisture is absorbed by the masonry, carrying with it sooty, tar deposits which then appear on the face of the plasterwork as an unattractive brown stain.

CAPS

A ventilated cap at the top of a chimney will prevent water ingress but allow through ventilation. Clay, metal and plastic caps are available – since the caps are very prominent choosing one with a good appearance is important. Caps are subject to large wind forces and so must be attached firmly. They can cause considerable damage and be very dangerous if they blow off.

Installing a cap provides the best ventilation for the disused chimney, with ample fresh air moving up its entire length. It is relatively straightforward to achieve. The disadvantage is that in most cases the inner face of the chimney breast will be made of a thin brick layer, creating a cold bridge to the interior.

VENTING INTERNALLY

The disused chimney is sealed from the outside by a hard capping at the top. The flue is vented both at the base and at a high level in the upper floor. Through-ventilation is by warm, internal air.

Internal ventilation is most often used when the chimney stack above roof level has been in poor condition and has had to be dismantled. It is less suitable where the chimney stack is still in place, as the upper portion, lacking ventilation, can become damp. There may also be problems with chimneys on outside walls as condensation from moist air from indoors can form on the cold outer skin. If the flue is sooty ventilating it internally can lead to unpleasant smells. Finally thought should also be given to the possibility of fire and smoke passing up through the disused flue from lower to upper floors: in buildings with fire compartmentalisation this may not be acceptable: in other buildings it would be sensible to at least fit a smoke detector by the upper vent.

INTERNAL TO EXTERNAL VENTILATION

The base of the flue is partially blocked to restrict airflow. This could be achieved by inserting a balloon closing an existing damper or by installing a register plate with ventilation holes. Alternatively the fireplace could be blocked by a panel at its opening with a vent inserted in the panel.

BALLOONS

A flue balloon is the quickest way to close the base of a flue that is not being used. These thick plastic balloons are available in various sizes and are normally inflated by a foot pump. Take care not to block the base of the flue completely.

Balloons are less appropriate for occasionally-used flues. Removing and reinstalling them can be awkward and dirty and they will melt if left in place accidentally. A better solution is a damper, although these are costlier and more disruptive.

A balloon and cap is the simplest solution. However, some warm air will continue to be lost up the flue, draughts and wind noise will not be completely eliminated. There may also be a risk of condensation inside the flue when it is cold and when warm moist air from inside the building flows through it. This means that internal to external ventilation is best suited to internal chimneys rather than those on the outside walls of buildings.

RETENTION OF CHIMNEYS, STACKS AND POTS

Chimneys can be key features that contribute to the significance and character of historic buildings. They may also fulfil structural functions. In listed buildings, consent is needed to remove chimney pots and dismantle chimney stacks. In conservation areas chimneys are frequently subject to special planning controls.

Removing internal chimney breasts is best avoided if at all possible. Such work would need structural engineering advice and Building Control approval and if the building is listed, Listed Building Consent.

CONDENSATION

All air contains some water vapour, but warm air can hold more water vapour than cold air. When warm, damp air is cooled it will reach a temperature - the 'dew point' - at which it can no longer hold all the vapour in it and some will condense out.

Warm damp air passing over a cold surface will be cooled locally below the dew point and condensation will take place. This effect causes the familiar condensation on the inside of cold windows.

USING CHIMNEYS FOR VENTILATION

If a disused flue is vented from inside to outside it can provide useful 'trickle' ventilation, for example in rooms with well-fitting windows that allow only limited air infiltration. If a suitable flue runs past, extra vents can even be provided for rooms that did not originally have fireplaces.

Disused flues can also house ducts from extractor fans, for example from kitchens and bathrooms, running, say, to a discreet airbrick on the back of a disused flue. This can often provide a less intrusive solution than a cowl projecting through a roof line or a vent through a façade.

When venting extractors into a chimney, make sure that an air duct runs the full distance along the flue and is sealed around the point of discharge, e.g. the air brick. Otherwise, moist air venting into the flue could condense, causing damp and staining problems.

MAINTAINING DISUSED FLUES

All disused flues require regular maintenance. The greatest risk is from birds' nests or other debris entering the chimney from above, or from building debris (old parging or broken withes) from the flues themselves. Either form of debris can block flues in unexpected places, leading to damp, smells, staining and other problems. The simplest way to check for and clear such debris is to have the disused flues swept.

Further information

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SOURCES OF INFORMATION AND ADVICE:

BFCMA (British Flue and Chimney Manufacturers Association)

2 Waltham Court,

Milley Lane,

Hare Hatch

Reading, Berkshire,

RG10 9TH United Kingdom

Tel No: + 44 (0)118 940 3416

E-mail: bfcma@feta.co.uk

CORGI (The Council for Registered Gas Installers)

1 Elmwood,
Chineham Park
Crockford Lane
Basingstoke
Hampshire
RG24 8WG
Consumer advice - 0800 915 0485
www.trustcorgi.com

HETAS (Heating Equipment Testing and Approval Scheme)

Orchard Business Centre
Stoke Orchard
Gloucestershire
GL52 7RZ
General inquiries 0845 634 5626
www.hetas.co.uk

OFTEC (The Oil Firing Technical Association)

Foxwood House,
Dobbs Lane,
Kesgrave,
Ipswich
IP5 2QQ
0845 65 85 0800
www.oftec.org

NACS (The National Association of Chimney Sweeps)

Unit 15 Emerald Way
Stone Business Park
Stone, Staffordshire
ST15 0SR
01785 811732

ENERGY EFFICIENCY IN
HISTORIC BUILDINGS –
OPEN FIRES, CHIMNEYS
AND FLUES

www.chimneyworks.co.uk

NACE (The National Association of Chimney Engineers)

PO Box 849

Metheringham

Lincoln

LN4 3WU

Tel: 01526 322555

www.nace.org.uk

English Heritage National Offices

North East

English Heritage
Bessie Surtees House
41 - 44 Sandhill
Newcastle upon Tyne
NE1 3JF
Tel: 0191 269 1200
E-mail: northeast@english-heritage.org.uk

North West

English Heritage
3rd floor Canada House
3 Chepstow Street
Manchester
M1 5FW
Tel: 0161 242 1400
E-mail: northwest@english-heritage.org.uk

Yorkshire and the Humber

English Heritage
37 Tanner Row
York
YO1 6WP
Tel: 01904 601901
E-mail: yorkshire@english-heritage.org.uk

West Midlands

English Heritage
The Axis
10 Holliday Street
Birmingham
B1 1TG
Tel: 0121 625 6820
E-mail: westmidlands@english-heritage.org.uk

East Midlands

English Heritage
44 Derngate
Northampton
NN1 1UH
Tel: 01604 735400
E-mail: eastmidlands@english-heritage.org.uk

ENERGY EFFICIENCY IN
HISTORIC BUILDINGS –
OPEN FIRES, CHIMNEYS
AND FLUES

East of England

English Heritage
Brooklands
24 Brooklands Avenue
Cambridge
CB2 8BU
Tel: 01223 582700
E-mail: eastofengland@english-heritage.org.uk

London

English Heritage
1 Waterhouse Square
138 - 142 Holborn
London
EC1N 2ST
Tel: 020 7973 3000
E-mail: london@english-heritage.org.uk

South West

English Heritage
29 Queen Square
Bristol
BS1 4ND
Tel: 0117 975 0700
E-mail: southwest@english-heritage.org.uk

South East

English Heritage
Eastgate Court
195-205 High Street
Guildford
GU1 3EH
Tel: 01483 252000
E-Mail: southeast@english-heritage.org.uk

The Conservation Department

English Heritage
Room 2/20, NMRC
Kemble Drive
Swindon
SN2 2GZ
Tel: 01793 414963
E-mail: conservation@english-heritage.org.uk

ENERGY EFFICIENCY IN
HISTORIC BUILDINGS –
OPEN FIRES, CHIMNEYS
AND FLUES

English Heritage is the Government's statutory adviser on the historic environment. English Heritage provides expert advice to the Government about all matters relating to the historic environment and its conservation.

The Conservation Department promotes standards, provides specialist technical services and strategic leadership on all aspects of the repair, maintenance and management of the historic environment and its landscape.

This guidance has been prepared on behalf of English Heritage by Oxley Conservation under the direction of Phil Ogley and has been edited by David Pickles, Ian Brocklebank and Chris Wood

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Telephone: 0870 333 1181 ☐

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E-mail: customers@english-heritage.org.uk