11 Fireplaces, Flues and Chimney Stacks

11.1 Introduction

Chimney and fireplace problems usually fall into two categories: those due to physical decay of the structure and those which cause the fireplace to smoke.

Atmospheric pollution caused by gases and fumes from old solid fuel fireplaces is a potential danger to health and the instability of many chimney stacks is a hazard that needs close examination.

A comparison of pre-World War II housing and post-war housing shows that very few houses from the latter period have chimney stacks. Single flue stacks are common in older domestic properties and are usually found serving a kitchen boiler.

It is difficult to ascertain the number of fireplaces in old dwellings that are no longer required, but a considerable number of dwellings could be improved by having the surrounds and grates removed and the fireplace opening sealed. If the stacks are to be retained but capped off and the fireplace opening sealed it is important to state in the report that the flues are to be ventilated to the external air at head and foot. Alternatively, if the stack is taken down to below roof level and capped there is no need to ventilate the flue. The chimney breasts and flues will normally be retained since to remove them would be a costly operation. In addition to this the owner would probably wish to utilise the flue for a gas heater.

The condition and design of each fireplace and its surround should be carefully considered. Where requirements of floor and wall space permit, good period pieces in sound condition should be retained. This is obviously a matter which should be discussed with the owner who may well require the surround and open fire for decorative purposes. During the past 20 years there has been a revival of interest in the traditional fireplace as a working and decorative feature and a wide range of reproduction fireplace surrounds are now available.

Before making a decision concerning the use of an open fire the surveyor would be wise to consult the local authority with regard to the Clean Air Act 1956 (as amended by the 1968 and 1993 Acts). Under the Act, the local authority with the approval of the Secretary of State may declare the whole or any part of its area to

Building Surveys and Reports, 4th Edition James Douglas and Edward A. Noy
 ISBN: 978-1-405-19761-8

be a smokeless zone. The Act makes it illegal to emit smoke from a chimney within a smokeless zone. There is obviously no point in advising a client to reconstruct a period fireplace for the burning of wood or non-smokeless coal. However, an owner of a dwelling situated in a smokeless zone may apply for a grant towards the cost of converting the fires.

In the following the most common problems associated with domestic fireplaces and chimneys and those connected with industrial plants will be considered.

11.2 Domestic fireplaces and flue entry

The majority of complaints against old fireplaces are usually concerned with their tendency to smoke. The surveyor investigating such a problem will probably find that the cause is due to an inadequate flow of air. The normal action of a fireplace depends on a continuous current of air passing up the flue and carrying with it the gases of combustion. It is, therefore, necessary to have a reasonable supply of air entering the room and passing through the fireplace into the flue and an unobstructed exit for the gases as they leave the chimney. In fact, it is the most important factor in preventing the chimney smoking. If the air supply or chimney is obstructed a check on the up-current of air will occur and down-draught may result.

The leading reformer in fireplace and flue design and the most frequently quoted authority is Benjamin Thompson (1753–1814) better known as Count Rumford (Billington & Roberts, 1982). The principles of design that he laid down are still generally applied by the Building Research Establishment. The following are the essential principles regarding fireplace design for open solid fuel burning grates:

- Correct design of the throat, which should be 100 mm from front to back and the width is determined by the splaying of the sides and back of the fireplace.
- To cause a two-way circulation of air in the flue and prevent soot and rain from falling into the fireplace, a smoke shelf should be provided. The shelf should be horizontal and level and should be between 150 and 200 mm above the top of the fireplace opening.
- Immediately above the throat there should be a smoke chamber, the same depth as the flue. The sides should taper inwards at an angle of 60° until the flue is reached.
- The fireplace should have splayed sides to reflect the heat into the room.
- The depth of the fireplace should be between one third and one half of the width of the front opening.
- The flue should have a cross sectional area of one tenth of the area of the fireplace front opening.
- The front of the fireplace opening should have an equal width and height.
- The upper portion of the fireback should be sloped outwards and the sides angled to reflect heat out into the room.

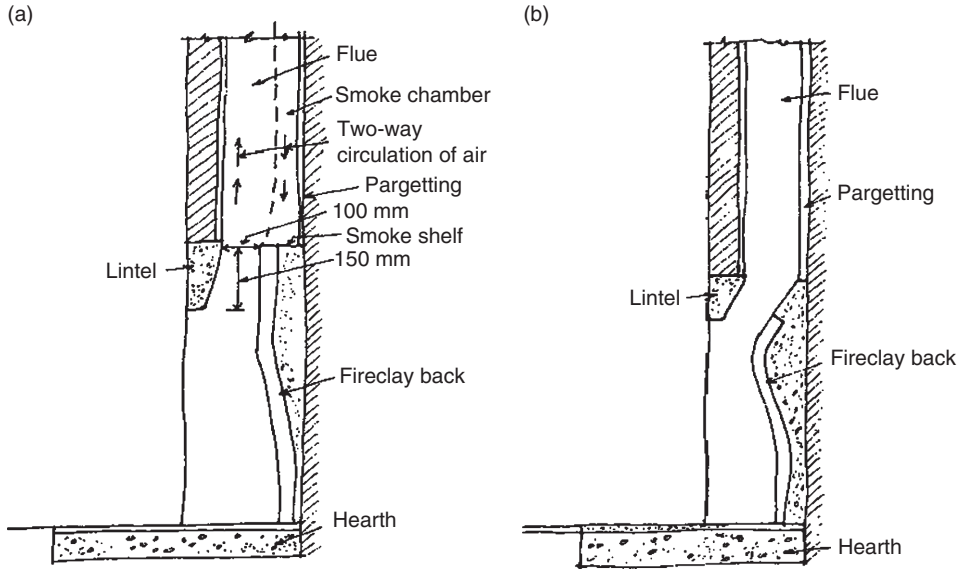

Figure 11.1 (a) Section through fireplace designed on the principles of Count Rumford. (b) Fireplace design commonly adopted in modern work

In practice of course, the surveyor will often find that these ideal conditions may not always occur. The fireplace and flue entry shown in Figure 11.1a has been designed on the Rumford principles (Billington & Roberts, 1982) and Figure 11.1b shows a section commonly adopted in modern work which is usually successful. The surveyor will often find that dwellings erected in the past 40 years have been fitted with precast throat units which ensure that the throat is formed to the correct dimensions.

11.3 Down-draught due to external conditions

A steady blow back of smoke can also be due to unfavourable site conditions. As the wind strikes buildings and trees, areas of air pressure and suction are set up. The area of pressure is on the side which the wind strikes and the area of suction on the opposite side. These areas extend above the roof, whether the roof is flat or pitched. Where a badly placed chimney is in an area of high winds, the pressure may be greater than the upward pressure of the smoke rising up the flue, and therefore a down-draught will result. The main lesson to be learnt from this is that the chimney outlet should be high enough to avoid interference from pressure and suction. Where it is clear that the existing outlet is too low, the almost certain remedy is to raise it to bring the outlet above the disturbed area. If this is done by building up the chimney in the existing materials it is well to remember that no brick chimney should rise more than six times its width (see Figure 11.2a).

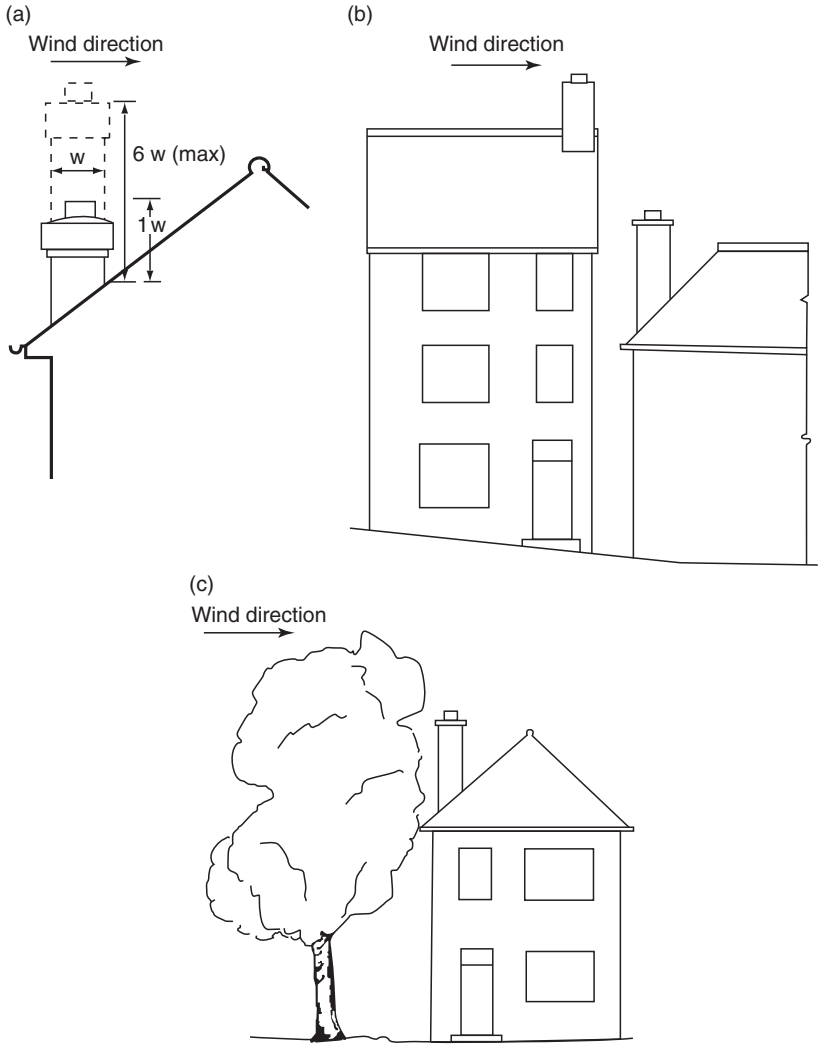

Figure 11.2 (a) Chimney lower than ridge causing down-draught. (b) Chimney too low in relation to higher adjoining building. (c) Tree in too close proximity to chimney causing down-draught

The building regulations require that the chimney outlet should be 1 m above the highest point of the intersection of the chimney stack and roof slope as shown in Figure 11.3. Adjacent buildings modify the areas of pressure and suction around the building. In some cases it is not sufficient to carry the chimney up 1 m above the ridge. A single storey building may have the ridge at a much lower level than that of the adjoining buildings. On steep hills one building may be lower than an adjoining building. In Figure 11.2b the building in the lower position has a chimney which is below the ridge level of the adjoining building

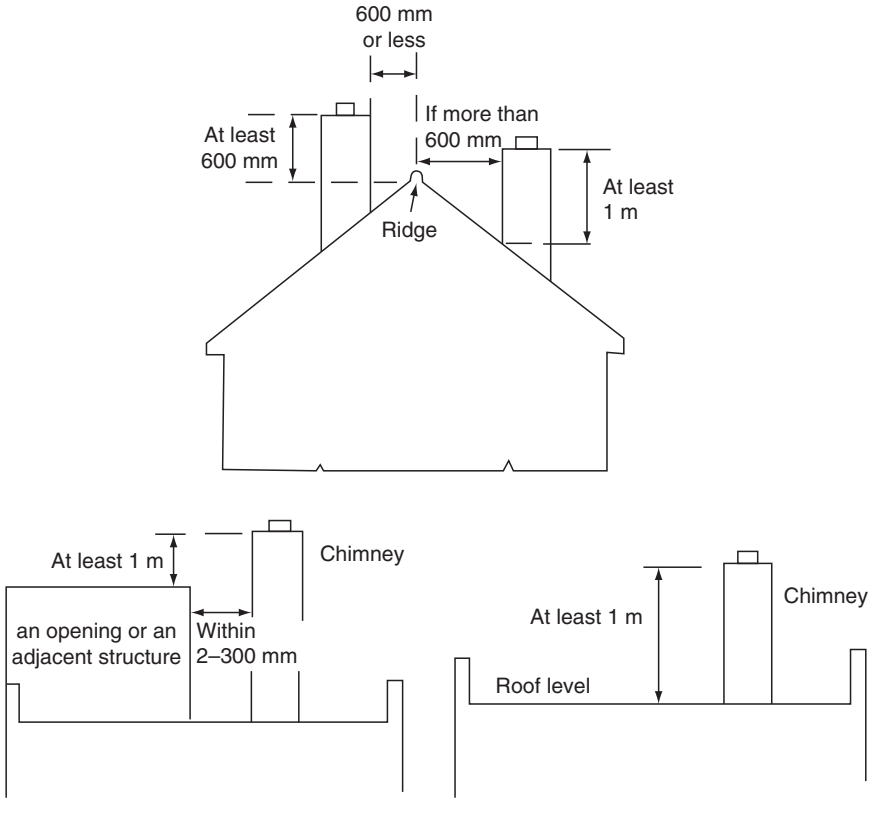

Figure 11.3 Minimum chimney heights laid down in the Building Regulations for solid fuel and oil burning appliances

although above its own ridge. The lower chimney will probably suffer from down-draught. The remedy is to take the chimney up to a higher level which may make it necessary to install special bracing. A possible alternative is to recommend a change in the form of heating. Tall trees near a building may cause down-draught by creating areas of pressure and suction. A typical case is shown in Figure 11.2c. If it is impracticable to raise the chimney above the area of pressure, the tree should be lopped.

If wind pressure or suction due to wind blowing down on the chimney outlet is the problem, then a favourite solution is to install one of the many types of cowl that have been designed for this purpose. Surveyors dealing with this problem should remember that cowls are not always the answer to down-draught and smokey fires. The probability is that there will be faults in the fireplace and at the chimney top. Some types of cowl restrict the air flow and often make the problem worse and in other cases the cowl acts as a trap for soot which builds up inside and reduces chimney capacity. The lobster-back cowl is probably best for such

situations. It swivels freely in the wind and should create suction at the right point. The tall 'Mancone' cowl works reasonably well, adds about 1 m to the height of the chimney and has no ledges to catch soot. No definite opinion can be expressed as to the effectiveness of any particular type. Everything depends on local circumstances. Cowls should not be recommended until any obvious defect in the fireplace or chimney has been remedied.

In this complex situation it is suggested that the surveyors, with the aid of binoculars, commence the examination of the suspect chimney and roof and work methodically along the roofs of the adjoining buildings or other obstructions compiling notes and sketches as they go. Examination of the external conditions will tell them a good deal when their inspection is taken in conjunction with their survey notes relating to the interior.

11.4 Flue investigation

Practical conditions usually decide the position of bends. Provided that the change of angle is slight the position appears to be immaterial. The run of the flue can easily be checked with a set of chimney sweep's rods. Great changes in the direction of a flue are certainly not desirable. Under the current Building Regulations, there should not be more than two bends and where a bend is necessary it should make an angle with the vertical of not more than 45°. Flues that are of low inclination will collect soot and mortar droppings causing partial blockage. In older flues blockages may be the result of loose pargetting breaking away from the flue wall and becoming jammed across a bend. When faced with such problems the best course of action is to have the flues swept. Using a scraper at the end of the rods usually clears small loose obstructions. If rodding fails to clear the flue, it will at least enable the surveyor to fix the position of the obstruction by measuring the rodding length. However, in difficult cases where extensive flue damage is suspected then fibre-optic devices described in Section 2.5 will enable the surveyor to detect cracks and other concealed failures within the flue. Fibrescopes are only 6 mm in diameter and can be passed through a predrilled hole in the brick mortar joint enclosing the flue.

Condensation problems are usually found in flues serving domestic boilers and slow combustion stoves that do not contain a flue liner. Brick chimney stacks situated on the external walls of a dwelling are most vulnerable to this type of attack. As the flue gas flows upward it cools and by the time it reaches the top of the chimney it no longer keeps the side of the flue warm. Condensation will then occur on the cool surface. When the products of combustion condense on the surfaces of the flue they may deposit tarry residues and set up sulphate attack on the pargetting and mortar joints. The sulphate attack causes the mortar to expand and leads to distortion in the chimney stack (see Section 11.10). In cases of tarry compounds forming inside the flue the surveyor will probably find that the decorative finishes on the chimney breasts are likely to be discoloured. If damage is slight the surveyor may consider it possible to recommend the insertion of a flexible metal liner.

Leaking flues are not uncommon and are often difficult to trace. If the lining and joints in the brickwork decay, smoke may leak from one flue to another or from a flue into the roof space. Leakages through the outer walls of the flues are easy to trace, but leakages in the 'withes' causing smoke to pass from one flue to another are often difficult to deal with unless they are near the fireplace opening. One method of detecting leaking joints is by burning special smoke pellets in the fireplace. The type of smoke pellets required for such tests are produced by P H Smoke Products Ltd, Fairfield Works, Glen View Road, Eldwick, Bingley, West Yorkshire.

11.5 Flues serving gas fires

When carrying out surveys of domestic properties the surveyor will often find that gas fires have been fitted to an existing fireplace and chimney. The following points should be checked:

- No opening should be formed in a flue except for cleaning and inspection, when the opening should be fitted with a non-combustible gas-tight cover.
- Problems often occur in old properties when the flues to gas-fired water heaters terminate in unventilated roof spaces. The danger from fumes, condensation and fire makes it essential that such flues are discharged into the open air. If this is not the case then the surveyor should recommend that the flue is carried up to the ridge.
- It has to be remembered that high-rated appliances need flues with stainless steel liners throughout. The masonry flue should be sealed around the liner top and bottom with a clamp sealing plate.
- Active flues should be fitted with terminals and disused flues with a cap. The capping usually consists of a half-round clay ridge tile. It is essential to exclude damp in order to prevent sulphate damage.
- Outlets from flues should be so situated externally that air may pass freely across at all times and should be at least 600 mm from any opening into the building.

Many properties erected during the past 50 years have been fitted with prefabricated block chimney flues which are built into the inner skin of the wall. They are only suitable for gas appliances and are often visible in a brick gable end or party wall in the roof space. (Gas appliances will be dealt with in Sections 14.7 and 14.8.)

11.6 Flues serving oil-fired boilers

Oil-fired boilers are not likely to cause chimney problems unless they are run with too rich a mixture, in which case condensation may be in evidence. The design and condition of the flue terminal should be considered. Gas terminals are often

used on oil-burning flues and tend to restrict the exit point. Sticky soot deposits may accumulate around the terminal outlet and block the chimney.

11.7 Hearths

The size and construction of the hearth is important. A constructional hearth must be of incombustible material properly supported and must be at least 125 mm thick; extend at least 150 mm at each end beyond the fireplace opening and project at least 150 mm from the chimney breast. If the hearth is freestanding then the size must be at least 840 × 840 mm. The upper surface must be at or above floor level. However, a point the surveyor should note is that under the current Building Regulations, if the hearth already exists and was built before 1 February 1966 the provisions described above need not be met as regards the projection of the hearth and size of the freestanding hearth.

11.8 Old fireplaces

When carrying out an examination of properties built in the seventeenth and eighteenth centuries the surveyor will find many different types of fireplaces, according to the age of the dwelling. Some early fireplaces of the inglenook type resemble caverns with large straight flues and sometimes the brick divisions or 'withes' between the respective flues have burnt away. The principles stated in Section 11.2 are, therefore, difficult to apply unless the design is to be radically changed by reconstructing the interior of the fireplace. In fireplaces of this type the flues are often too large and therefore require a greater air supply to prevent smoking. The surveyor will often find that the air flow has been reduced by various draught excluders around windows and doors. The air flow can be tested by opening a window or door and seeing if the fireplace still smokes. If this is the case then the remedy is to increase the air supply. This can be done by various methods including the following:

- With a suspended floor the air supply can be increased by the installation of a metal grille immediately in front of the hearth.
- If the fireplace is situated on an external wall then grilles can be inserted in the walls on either side of the fireplace.
- The problem is more difficult to solve if the floor is solid and the fireplace is situated on an internal wall. In such cases an adequate air supply can often be obtained from an adjoining room or hall by inserting grilles on either side of the fireplace.

Inglenooks usually have excessively wide and high fireplace openings and are often fitted with a small fire basket which means that the fire is no longer in proportion to the chimney. Even with the installation of air vents these large fireplace

openings may still emit smoke. This calls for changes in the design of the recess and flue. The opening can be reduced by raising the hearth and providing a metal hood fitted with a flue liner to reduce the chimney size.

When undertaking an examination of an old fireplace opening and flue it is advisable to check that no bressummer, ends of joists or beams are buried in the flue walls and if anything of a dangerous nature is found the details should be described in the surveyor's report.

11.9 Rebuilding

More complex problems concerning fireplaces and flue construction might entail a complete rebuilding. In such cases, it is advisable for the surveyor to consult the approved document J1/2/3 (Heat producing appliances) which is a practical guide to meeting the requirements of the Building Regulations.

11.10 Chimney stacks

Chimney stacks are often a neglected part of a building and being very exposed to the elements are thus susceptible to decay. A good pair of binoculars is sufficient when investigating chimney faults externally. Leaning stacks often have more serious internal defects. The best course of action here is to have the chimney swept and examined by using fibrescopes inserted through a predrilled hole in a mortar joint as described in Section 11.4. In such cases a builder's 'attendance' is usually necessary to provide extension and roof ladders etc.

11.10.1 Common defects

The defects to be considered are those arising from the following causes:

(1) As already mentioned, sulphate attack causes the mortar to expand and this leads to a gradual curvature or leaning of the stack which can be extensive on rendered stacks. The lining or pargetting can also be attacked by the products of combustion as they rise up the flue. Sulphate attack on a typical kitchen boiler flue is shown in Figure 11.4a where the shrinkage cracks have enlarged on the horizontal brick joints as the sulphate attack progresses. A chimney stack which has begun to lean is generally safe provided a plumb line suspended from the top of the stack does not pass outside the 'middle third' of its area as shown in Figure 11.4b. If the rate of lean appears excessive the surveyor should recommend that the stack should be demolished to the level at which it appears reasonably perpendicular and rebuilt using a sulphate-resisting cement. If the chimney is old and is to be used in conjunction with a gas appliance and is not protected with a flue liner, the rebuilding of the stack will provide a good opportunity to install a flexible liner.

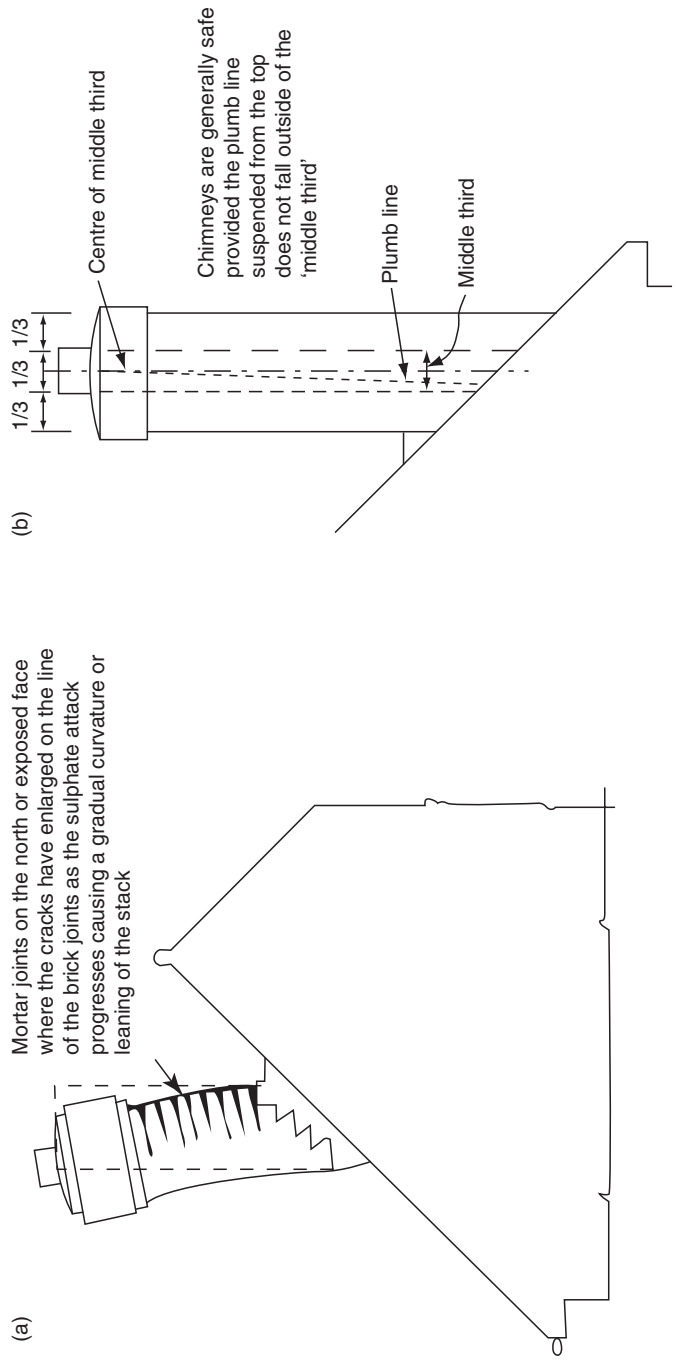

Figure 11.4 (a) Sulphate attack on a typical kitchen boiler flue. (b) Middle third rule

(2) Erosion of a brick or stone chimney by the action of wind, rain and frost may lead to crumbling or fractures and a general weakening of the stack. Small defective areas can be repaired, but badly damaged chimneys will often require rebuilding.

(3) The damp-proof courses, back gutters, soakers and stepped flashings should also be carefully examined. Stacks situated on external walls at eaves level are most likely to give rise to damp patches in rooms just below roof level, due to the short distance between the roof coverings and ceiling.

(4) Leaning pots indicate a fracture in the flaunching and probably of the brick courses below. These defects should be detectable by using the binoculars. On old buildings tall chimney pots were often used to prevent down-draught. They are frequently unstable and are best removed and other means recommended to prevent down-draught as discussed in Section 11.3. In the seventeenth century and onwards stacks were often finished with decorative chimney pots, which should be retained if they are of aesthetic merit. If badly deteriorated, the pots may have to be dismantled, but minor fractures can sometimes be repaired.

(5) Where old chimneys are part of a classical design and considered to be of some architectural importance then it is advisable to retain the stack. It may be necessary to carry out a number of repairs, but if the stack is no longer to be used then careful consideration must be given to the matter of ventilation and cleaning of the flues in order to avoid damp, frost and sulphate damage. To ventilate a flue properly it should not be sealed at either top or bottom. When dealing with such cases it is advisable to recommend that some form of capping, such as a half-round ridge tile, or a cast concrete slab is laid over the top of the chimney supported on 300 mm high brick or stone piers at the corners. A ventilator should also be provided in the blocked up fireplace opening.

(6) In cases of extensive re-roofing and where the stacks are either redundant or structurally unstable, consideration should be given to demolishing the stack to below roof level and roofing over it and the top of the flue sealed with slate or a concrete slab. In such cases all associated fireplaces should be sealed off without venting the room. However, it is essential to ventilate to the outside redundant stacks situated on the exterior wall (BRE GBG 2).

(7) When carrying out an examination of a damp stack, the adjacent roof timbers should be checked for wet rot and insect attack.

11.11 Industrial chimney shafts

Tall chimney shafts attached to industrial or large commercial premises may be constructed of brickwork, reinforced concrete or steel (self-supporting or with guys). Brick or concrete shafts are either freestanding or are constructed within a building. Steel chimneys are generally classed as temporary structures which are inspected and licensed for certain periods.

A great number of chimney shafts of all types have been erected in the past, many of which have been demolished. The design of brick and concrete shafts is either calculated by engineers or designed in accordance with the Building Regulations for 'uncalculated' brick shafts. All shafts should be lined with firebricks to protect the main structural materials from the effects of high temperatures.

A preliminary examination with binoculars will indicate the general condition of the external surfaces of the shaft. The points to be checked are as follows:

- The condition of the pointing and jointing.
- Any surface cracks or fractures to the brickwork or concrete.
- The condition of the chimney cap and oversailing courses (if any).

On completion of this preliminary examination the surveyor will be able to obtain a fairly accurate assessment of the situation and the possibility that the services of a specialist in this field may have to be employed to report on the high level aspects and internal condition of the shaft which is outside the professional knowledge of the surveyor. This information should be communicated to the client as soon as possible with some details of the specialist's fee as mentioned in Section 1.3.

There are firms who specialise in the examination of high level structures including chimney shafts. They employ experienced qualified men who examine and test the efficiency of tall chimney shafts using closed circuit cameras, video recording equipment and boroscopes which enable them to inspect parts of the shaft which are inaccessible by any other means. This examination is followed by a full report and cost of repairs if found necessary.