BS 7967:2015

BSI Standards Publication

# Guide for the use of electronic portable combustion gas analysers for the measurement of carbon monoxide in dwellings and the combustion performance of domestic gas-fired appliances

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# Foreword

## Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 28 February 2015. It was prepared by Panel GSE/30/-/21, *Gas Analysers*, under the authority of Technical Committee GSE/30, *Gas installations (1st, 2nd and 3rd family gases)*. A list of organizations represented on this committee can be obtained on request to its secretary.

## Supersession

This British Standard supersedes BS 7967-1:2005, BS 7967-2:2005, BS 7967-3:2005 and BS 7967-4:2007, which are withdrawn. BS 7967-5, which covers the use of electronic portable combustion gas analysers in non-domestic premises, remains current.

## Information about this document

This British Standard is intended to be used in conjunction with the gas appliance commissioning, servicing and maintenance instructions and the *Gas Industry Unsafe Situations Procedure* [1].

Its purpose is to provide:

a) information that is intended to assist gas operatives (see **3.12**) in considering all the relevant issues and circumstances relating to the identification of sources of fumes and smells and the cause of carbon monoxide (CO) detector activation, or when spillage/leakage of combustion products is suspected or encountered from an unknown source;

b) information on combustion performance characteristics of a range of gas appliance types and the levels at which remedial action is to be taken;

c) advice on the actions to be taken when elevated concentrations of carbon monoxide (CO) are identified in dwellings;

d) the appropriate method(s) for using an electronic portable combustion gas analyser to:

- check the combustion performance of gas appliances;
- measure the concentrations of CO within a dwelling and, in certain circumstances (see Clause **1**, Notes 4 and 5, and Commentary on **8.1**), detect the presence of carbon dioxide ($CO_2$); and
- identify sources of the CO spillage/leakage;

e) good practice guidance on the use of electronic portable combustion gas analysers as part of a servicing and/or maintenance procedure for gas appliances in dwellings; and

*NOTE Electronic portable combustion gas analysers are often referred to colloquially as "flue gas analysers" (FGAs).*

f) guidance on the use of combustion gas analysis as a diagnostic tool to assist a gas operative to confirm the safe and efficient functioning of a gas appliance when work has been done on that appliance.

This standard:

1) is not intended to be an exhaustive step-by-step procedure, and gas operatives need to hold an appropriate certificate of gas safety competence (see Clause **4**) and use sound judgement in deciding how best to respond to individual cases. Where a gas operative is carrying out routine servicing or repair work on an appliance, testing could indicate a spillage/leakage problem. In such cases, there is no obligation to carry out all the considerations, inspections and tests described in this guidance as the gas operative has personally identified the

issue and the source of spillage/leakage is known. Only those subclauses in this standard that are concerned with the particular appliance involved would be relevant in such circumstances;

2) supplements gas appliance manufacturers' servicing requirements through a generic approach to servicing and maintenance activity and by identifying situations where combustion gas analysis cannot be deployed or is not appropriate;

3) does not intend that a combustion gas analysis be used as a substitute for normal servicing and/or maintenance carried out in accordance with the gas appliance instructions;

4) recognizes that it is important that the gas appliance instructions are followed; and

5) continues to use the term "flue" in its traditional UK sense, as any structure used to conduct the combustion products from an appliance to the outside air; as opposed to the European approach in standards, where a "flue" is only the passageway in the structure through which the combustion products flow.

The documents available as downloads from the sites referenced throughout the document were last accessed on 10 February 2015.

### Use of this document

As a guide, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification or a code of practice and claims of compliance cannot be made to it.

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to competent people (see Clause **4** for information on competence), for whose use it has been produced.

### Presentational conventions

The guidance in this standard is presented in roman (i.e. upright) type. Any recommendations are expressed in sentences in which the principal auxiliary verb is "should". The word "may" is used in the text to express permissibility, e.g. as an alternative to the primary recommendation of the clause. The word "can" is used to express possibility, e.g. a consequence of an action or an event.

*Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.*

Notes give references and additional information that are important but do not form part of the recommendations. Commentaries give background information.

### Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

Attention is drawn to the following statutory regulations.

- The Gas Safety (Installation and Use) Regulations 1998 [2]
- The Gas Safety (Installation and Use) Regulations (Northern Ireland) 2004 [3]
- The Gas Safety (Application) Order (Isle of Man) 1996 [4]
- The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013 [5]
- The Gas Safety (Management) Regulations 1996 [6]
- The Gas Safety (Management) Regulations (Northern Ireland) 1997 [7]

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# 1 Scope

**1.1** This standard provides guidance for gas operatives on:

a) the general use of an electronic portable combustion gas analyser conforming to BS EN 50379-3 and BS 7927:1998 incorporating Amendment No. 1:1999;

*NOTE 1 This standard assumes that a portable combustion gas analyser [often referred to colloquially as a "flue gas analyser" (FGA)] of the type specified in BS EN 50379-3 or BS 7927:1998 incorporating Amendment No. 1:1999 is available to the gas operative and the operative is competent in its use and the interpretation of any reading obtained. This competence can be demonstrated by satisfactory completion of the relevant ACS assessments, which cover the use of electronic portable combustion gas analysers. See Clause **4** for further information on competence.*

*NOTE 2 BS EN 50379-3 superseded BS 7927:1998 incorporating Amendment No. 1:1999 on 1 March 2007. However, electronic portable combustion gas analysers conforming to BS 7927:1998 incorporating Amendment No. 1:1999 remain acceptable for the purposes of this standard.*

b) the use of such an electronic portable combustion gas analyser to determine ambient levels of carbon monoxide (CO) and, in certain circumstances (see Notes 4 and 5, and Commentary on **8.1**), detect the presence of carbon dioxide ($CO_2$) in dwellings;

*NOTE 3 A definition of a dwelling is given in **3.7**.*

*NOTE 4 One of the main combustion products from gas appliances is $CO_2$, which is mainly regarded as an asphyxiant, but is also a toxic substance which could be present in the air in sufficient quantity to prove harmful. For guidance on the occupational health considerations of $CO_2$, reference can be made to the HSE Guidance note on Workplace exposure limits, EH40/2005 [8].*

*NOTE 5 Electronic portable combustion gas analysers that calculate $CO_2$ levels from an oxygen ($O_2$) measurement are:*

- *well proven for calculating $CO_2$ levels in combustion gases in the flue of an appliance;*
- *not suitable for measuring ambient levels of $CO_2$ in dwellings; and*
- *able to detect increases in the ambient $CO_2$ levels in ambient atmospheres and such increases in $CO_2$ will provide an early indication of increasing build-up of products of combustion in the room (see Commentary on **8.1**).*

c) the use of an electronic portable combustion gas analyser to measure CO and $CO_2$ in combustion products from the following types of gas-fired appliances:

1) flueless appliances (type A appliances);
2) open-flue appliances (type B appliances);
3) room-sealed appliances (type C appliances); and
4) all appliances for which the gas appliance manufacturer has provided a purpose-designed sampling point or specific sampling instructions;

*NOTE 6 Type A, type B and type C classification of gas-fired appliances is described in PD CEN/TR 1749 and in **3.21**.*

d) the use of an electronic portable combustion gas analyser as a diagnostic instrument to assist a gas operative:

1) in confirming safe and/or efficient operation at the time of commissioning, in accordance with gas appliance instructions;
2) in determining the level of servicing required for a gas-fired appliance;

3) in confirming satisfactory combustion following servicing in accordance with gas appliance instructions; and

4) in confirming satisfactory combustion following maintenance.

*NOTE 7 At the time of installation of a new appliance it is not necessary to carry out tests to measure the level of combustion products in the flue, unless the gas appliance instructions specify that a test be carried out (see **11.2**).*

*NOTE 8 Electronic portable combustion gas analysers are not to be used as a substitute for normal service and maintenance carried out in accordance with gas appliance instructions. This standard describes the options of how they can be used in conjunction with gas appliance instructions.*

**1.2** This standard gives recommendations on:

a) combustion performance action levels; and

b) actions to be taken when CO is detected in dwellings.

This standard is for use with appliances using 2nd or 3rd family gases.

*NOTE The general recommendations for 3rd family installations contained within this standard also apply to gas installations supplied with LPG/air mixtures used in the Channel Islands or the Isle of Man, provided:*

- *any installed gas equipment has been appropriately converted and is suitable for the gas being supplied, and*
- *the provisions of the standard do not conflict with local regulations or authorized local custom and practice.*

**1.3** This standard gives references to further information on the effects of CO.

*NOTE Information on the effects of CO can be found in the Institute for Environment and Health's IEH assessment on indoor air quality in the home (2): Carbon monoxide [9].*

**1.4** This standard does not:

a) cover the obligations of an emergency service provider (ESP) in responding to a gas emergency or procedures for investigating incidents that are reportable under Section 11(1) of the Reporting of Injuries, Diseases and Dangerous Occurrence Regulations (RIDDOR) 2013 [5] and the Gas Safety (Management) Regulations (GSMR) 1996 [6];

b) make recommendations arising from the determination of ambient $CO_2$ levels; or

c) deal with the measurement of combustion products such as nitrogen oxides and aldehydes.

*NOTE Combustion products from gas appliances also contain oxides of nitrogen (NOx), predominantly nitrogen monoxide (nitric oxide, NO) and nitrogen dioxide ($NO_2$). Although this standard does not cover the measurement of these substances, quantities of such products could be present in the air and could cause harm and irritation to humans. For guidance on the health considerations associated with these combustion products, see the Institute for Environment and Health assessment on indoor air quality in the home: Nitrogen dioxide, formaldehyde, volatile organic compounds, house dust mites, fungi and bacteria [10].*

# 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 7927:1998 incorporating Amendment No. 1:1999, *Heating appliances for domestic applications – Portable apparatus designed to detect and measure specific combustion flue gas products – Requirements*[1)]

BS 5440-1:2008, *Flueing and ventilation for gas appliances of rated input not exceeding 70 kW net (1st, 2nd and 3rd family gases) – Part 1: Specification for installation of gas appliances to chimneys and for maintenance of chimneys*

BS EN 50291-1, *Electrical apparatus for the detection of carbon monoxide in domestic premises – Part 1: Test methods and performance requirements*

BS EN 50291-2, *Electrical apparatus for the detection of carbon monoxide in domestic premises – Part 2: Electrical apparatus for continuous operation in a fixed installation in recreational vehicles and similar premises including recreational craft – Additional test methods and performance requirements*

BS EN 50292, *Electrical apparatus for the detection of carbon monoxide in domestic premises, caravans and boats – Guide on the selection, installation, use and maintenance*

BS EN 50379-3, *Specification for portable electrical apparatus designed to measure combustion flue gas parameters of heating appliances – Part 3: Performance requirements for apparatus used in non-statutory servicing of gas fired heating appliances*

# 3 Terms and definitions

For the purposes of this British Standard the following terms and definitions apply.

**3.1 action level**
appliance combustion performance at which action is to be taken

**3.2 ambient**
atmosphere relating to the immediate surroundings, e.g. air inside the dwelling, air outside the dwelling

**3.3 appliance compartment**
enclosure specifically constructed or adapted to accommodate one or more fuel-burning appliances

**3.4 box radiant gas fire**
gas fire designed to heat a room by both radiation and convection, incorporating radiant box-shaped lattice fronted elements mounted vertically or near vertical and of a design that does not seek to simulate a solid fuel fire bed

**3.5 customer**
occupier of the dwelling, the owner of the dwelling and any person with authority for the time being to take appropriate action in relation to any gas fitting therein

**3.6 customer-adjustable ventilation**
adjustable purpose-provided unit/assembly designed to allow ventilation

1) Withdrawn.

**3.7 dwelling**
unit of residential accommodation, including residential park homes, flats, bedsits, maisonettes, terraced, semi-detached and detached houses (including all such residential accommodation situated within or forming part of commercial or industrial or agricultural premises), leisure accommodation, and boats, excluding vessels with an international load line certificate

*NOTE It is recognized that the guidance can be applied to premises other than dwellings, such as those supplying a small number of clients on a bed and breakfast basis.*

**3.8 CO detector**
device that detects the presence of CO (see **7.1**)

**3.9 electronic portable combustion gas analyser**
electronic apparatus that detects and measures the presence of combustion gases and clearly displays the result

*NOTE Hereafter referred to in this standard as "gas analyser".*

**3.10 emergency service provider (ESP)**
person acting to prevent an escape of gas on behalf of a gas transporter

*NOTE This definition is consistent with Regulation 7(11) of the Gas Safety (Management) Regulations (GSMR)1996 [6].*

**3.11 full strip and clean**
work involving, but not exclusively, the gaining of access to the heat exchanger and burner assemblies and the removal of any corrosion products (such as shale) or debris that might impair the safe and efficient operation of the appliance

**3.12 gas operative**
person deemed competent to carry out work

*NOTE Persons deemed competent to carry out gas work are those who hold certificates of gas safety competence acceptable to Gas Safe Register, which include (without limitation) the Accredited Certification Scheme (ACS) and the Gas Services National Vocational Qualification (e.g. NVQ or SNVQ) that has been aligned with ACS. See Clause **4** for further information on competence.*

**3.13 GC number**
number assigned to some appliance models as part of an appliance indexing system

*NOTE GC numbers are made up of seven characters, which can be numbers or a combination of numbers and letters, e.g. GC 12-345-67. These are issued by British Gas and are included on an appliance data plate.*

**3.14 live fuel effect gas fire**
appliance designed to simulate a solid fuel appliance

**3.15 maintenance**
combination of all actions intended to retain an appliance in, or restore it to, a state in which it can operate safely

**3.16 permanent ventilation**
non-adjustable purpose-provided unit/assembly designed to allow ventilation

**3.17 safety check**
examinations and tests to ensure that a gas appliance and any associated flue/chimney operate safely

*NOTE An example of a safety check is the landlord's gas safety checks required by regulation 36(3) of the Gas Safety (Installation and Use) Regulations 1998 [2].*

**3.18 servicing**
regular and planned (usually annual) activity carried out on an appliance to check and ensure that it is working safely and correctly

**3.19 shaling**
progressive corrosion of the flueways of a cast iron heat exchanger, leading to the development of rust flakes

*NOTE Shaling can block the heat exchanger.*

**3.20 "suspect" gas appliance**
gas appliance which, after an initial appraisal, is considered to be a problem source

**3.21 types of gas appliance**

**3.21.1 type A appliance**
appliance not intended for connection to a flue or to a device for evacuating the combustion products to the outside of the room in which the appliance is installed

*NOTE Hereafter referred to in this standard as "flueless appliance".*

**3.21.2 type B appliance**
appliance intended to be connected to a flue that evacuates the combustion products to the outside of the room containing the appliance, with the combustion air being drawn directly from the room

*NOTE Hereafter referred to in this standard as "open-flue appliance".*

**3.21.3 type C appliance**
appliance in which the combustion circuit (air supply, combustion chamber, heat exchanger and evacuation of the combustion products) is sealed with respect to the room in which the appliance is installed

*NOTE Hereafter referred to in this standard as "room-sealed appliance".*

**3.22 work**
installation, maintenance, servicing, removal, permanent adjustment, repair, repositioning, alteration or renewal of a gas fitting or purging it of air or gas

*NOTE This term is consistent with the definition given in Regulation 2 of the Gas Safety (Installation and Use) Regulations 1998 [2]. Guidance on Regulation 2 is contained in the Health and Safety Commission (HSC) Approved Code of Practice and Guidance, Safety in the installation and use of gas systems and appliances [11].*

# 4 Competence

Persons carrying out work covered by the scope of this standard should ensure that they have the competence relevant for the task such as not to compromise the recommendations of this standard and, in particular, the safe installation, commissioning and operation of gas equipment.

*COMMENTARY ON CLAUSE **4***
*Competence requires sufficient knowledge, practical skill and experience to carry out the job in hand safely, with due regard to good working practice. Knowledge should be kept up-to-date with changes in law, technology and safe working practice.*

*There are three principal aspects to competence for work associated with gas-fired appliances; these are:*

*a) knowledge of the relevant Building Regulations [12], [13], [14], [15] for domestic premises;*

*b) ability to ensure that electrical work in dwellings is designed, installed, inspected and tested to the standard required by BS 7671;*

*c) registration for "gas work" with an appropriate authority.*

*It is a statutory requirement in Great Britain, Isle of Man, Northern Ireland and Guernsey (see Table 1) that all "gas work" [item c)] be carried out by a business or self-employed person(s) that is a member of a "class of persons" registered with a registration body which has been approved by an approval body (see Table 1) to operate and maintain such a register.*

*At the time of publication, the only body with approval to operate and maintain a register of individuals/businesses who are "members of a class of persons" is the Gas Safe Register. Thus, it is essential that all businesses or self-employed gas engineers are registered with the Gas Safe Register.*

*The qualifications which persons need to have to be deemed competent to carry out gas work are given in Table 2.*

Table 1 **Approval bodies and statutory regulations by country/territory**

| Country/territory | Approval body | Statutory regulations |
|---|---|---|
| Great Britain | Health and Safety Executive (HSE) | Gas Safety (Installation and Use) Regulations 1998 [2] |
| Isle of Man | Health and Safety at Work Inspectorate (HSWI) | Gas Safety (Installation and Use) Regulations 1994, as amended and applied by the Gas Safety (Application) (Isle of Man) Order 1996 [4] |
| Northern Ireland | Health and Safety Executive Northern Ireland (HSENI) | Gas Safety (Installation and Use) Regulations (Northern Ireland) 2004 [3] |
| Guernsey | Health and Safety Executive for the States of Guernsey [HSE (Guernsey)] | Health and Safety (Gas) (Guernsey) Ordinance 2006 [16] |

Table 2 **Competence requirements by country/territory**

| Qualifications | Great Britain and Isle of Man | Northern Ireland | Guernsey |
|---|---|---|---|
| Current certificate(s) of competence in the type of gas work to be conducted, issued by an awarding body accredited by the United Kingdom Accreditation Service (UKAS) (ACS certification) | ✓ | ✓ | ✓ |
| National/Scottish Vocational Qualification (N/SVQ accredited by Ofqual), which is aligned in matters of gas safety | ✓ | ✓ | ✓ |
| National/Scottish Vocational Qualification (N/SVQ accredited by Ofqual), which is aligned under the HSC ACoP arrangement [A)] as approved with the registration body | ✓ | ✓ | ✗ |
| Any other scheme recognized by the gas registration body for registration purposes | ✓ | ✓ | ✓ |

[A)] Guidance on the individual competence required for gas work is given in industry guidance IGEM/IG/1, *Standards of training in gas work – Criteria and guidance in the development and delivery of training programmes in gas work* [17].

*There are three principal aspects to competence for work associated with gas analysers. These are:*

*1) be competent in their use; and*

*2) have an understanding of the results obtained; and*

*3) have an awareness of the necessary safety actions and appropriate regulations (e.g. Gas Safety (Installation and Use) Regulations [2]).*

*This competence can be demonstrated by satisfactory completion of the relevant ACS assessments which cover the use of gas analysers.*

# 5 Gas analyser

## 5.1 Selection

**5.1.1** A gas analyser should conform to BS EN 50379-3 or BS 7927:1998 incorporating Amendment No. 1:1999.

*NOTE A more detailed description of a gas analyser is given in Annex A.*

**5.1.2** If the gas analyser is not marked as conforming to BS EN 50379-3 (or BS 7927:1998 incorporating Amendment No. 1:1999), the analyser manufacturer should be asked to provide written confirmation as to its suitability for the intended purpose.

**5.1.3** A gas analyser's sensor response for CO and $CO_2$ can be affected by the presence of other gases and vapours that can, for example, come from cooking activities or common household materials such as cleaning fluids, polishes and paints. This sensor cross-sensitivity can lead to inaccurate readings.

**5.1.4** The analyser instructions should be checked for what substances could interfere with analyser operation or reliability in the short or long term. If this information is not given or a substance not listed is suspected of causing interference, the gas analyser manufacturer should be consulted.

## 5.2 Preparation of gas analyser

### 5.2.1 Pre-checks before use

The gas analyser should be treated with care, and used and maintained in accordance with the gas analyser instructions. Before using the gas analyser it is essential to read operator manuals and ensure that the analyser has a current proof of calibration.

### 5.2.2 Preparation of gas analyser for use

The gas analyser should be switched on and the relevant "zero" procedure described in the gas analyser instructions should be carried out in outdoor air at a location as adjacent to the space in the building to be tested as is reasonably practicable. Once zeroed, it is essential that the gas analyser is not switched off during the test. If it is switched off, the gas analyser needs to be re-zeroed before taking any more readings.

These gas analysers read very low levels near to zero. Since they can fail to give any reading due to sensor failure, a check should be carried out using a flue gas sample, for example by measuring combustion products from a cooker grill burner or around a cold saucepan on a hotplate, or in the flue of an operating boiler.

For those gas analysers that calculate $CO_2$ from an $O_2$ measurement, it is good practice to check that the $O_2$ reading in outdoor air is 20.9%.

When $CO_2$ is being calculated, the relevant fuel gas should be selected on the gas analyser.

If the gas analyser cannot be zeroed, the gas analyser instructions should be consulted.

# 6 Investigation of reports of fumes, smells and spillage/leakage of combustion products in dwellings

## 6.1 Determining scope of investigation

*NOTE Gas operatives working in a customer's dwelling do so by invitation of the customer and it is imperative that any actions the gas operative might wish to take be done with the customer's permission.*

Having taken all necessary initial actions to protect life and property and given due consideration to the issues as presented/understood, it is essential that the gas operative decides whether the circumstances are within the scope of this guidance before commencing further investigation.

Where there has been no death, loss of consciousness or hospitalization due to gas, or where there have been GSMR investigations (see Commentary) which have been completed, the gas operative may inspect and test the gas installation and appliances in accordance with **6.2** to **6.6** in order to identify the extent of the problem and the remedial action required. However, in the latter case, the GSMR investigations are likely to have already identified the faulty appliance(s).

*COMMENTARY ON **6.1***
*In instances of death, loss of consciousness or hospitalization the ESP will normally have already attended the site and reported the incident, as required under the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) 2013 [5], to the Health and Safety Executive (HSE). In such circumstances the gas supplier is normally required under the Gas Safety (Management) Regulations (GSMR) 1996 [6] to carry out an investigation.*

*Where a gas operative becomes involved in a situation where it is identified that there has been a death or major injury, loss of consciousness or hospitalization, it is imperative that the gas operative ascertain whether the ESP and the gas supplier have completed their investigations. Where there is any doubt, it is imperative that the local HSE office be contacted for advice before any work is started or before any gas appliance installation is interfered with in any way. Where the gas supplier's investigation is still outstanding:*

*a) advise the customer that it is essential that the work to rectify any faults is postponed until the gas supplier's investigation has been completed; and*

*b) follow the advice given in Clause **13** and Clause **14**.*

## 6.2 Safety principles

### 6.2.1 Basic rules

Whenever attending reports of fumes, smells, spillage of combustion products in dwellings and/or CO detector activation, gas operatives have to:

a) consider their own safety as well as that of the occupants (see **6.2.2**); and

b) use a gas analyser or a personal CO alarm to ensure they do not enter atmospheres in which potentially dangerous levels of CO are present (see **6.2.2**).

*COMMENTARY ON **6.2.1**b)*
*If using a gas analyser, sample at head height in every room entered for at least 60 s.*

*If using a personal CO alarm ensure it is worn in accordance with the manufacturer's instructions.*

All investigations should adhere to the following basic rules in the order listed:

1) protect life;
2) protect property;
3) locate all fuel-burning appliances;
4) locate any escape of gas, fumes, smells or spillage/leakage of combustion products;
5) confirm the safe installation and operation of all suspect gas appliances;
6) make safe any identified unsafe appliances in accordance with the *Gas Industry Unsafe Situations Procedure* [1];
7) advise the customer of any remedial action that is required; and
8) complete all necessary reports, documentation and actions as advised in the *Gas Industry Unsafe Situations Procedure* [1] and Clause **13** and Clause **14**.

### 6.2.2 CO investigation action levels

The following actions should be taken when faced with the presence of CO in any area of the dwelling during the investigation process:

a) greater than 30 ppm – evacuate occupants to a safe environment (see Notes 2 and 3);
b) 0 to 100 ppm – safe for gas operative to enter property for 30 min and begin investigation;
c) greater than 100 ppm – stop work/turn off appliances, ventilate property and leave property immediately.

If, for any reason, CO levels do not fall sufficiently to allow the investigation to proceed, it is recommended that the property be evacuated/remain evacuated.

*NOTE 1 These are general atmosphere CO values and not peak values measured adjacent to an appliance. They can be indicated by a personal alarm monitor or measured in accordance with the relevant test method described in **8.3**.*

*NOTE 2 Advise others not to enter until the level has dropped below 10 ppm and preferably is down to outdoor background level.*

*NOTE 3 Gas cookers can produce concentrations of CO in excess of 30 ppm within the room for short periods of time, particularly grills on initial ignition. Such concentrations may be allowed, provided the cooker satisfies the tests described in **8.3.4.1** and is installed correctly to the cooker instructions and/or BS 6172.*

*COMMENTARY ON **6.2.2**a)*
*With the exception of cookers (see Note 3), advise occupants to move to a CO-free atmosphere if CO levels above 30 ppm are noted.*

*A CO-free atmosphere might be another room or necessitate advising the occupants to leave the dwelling.*

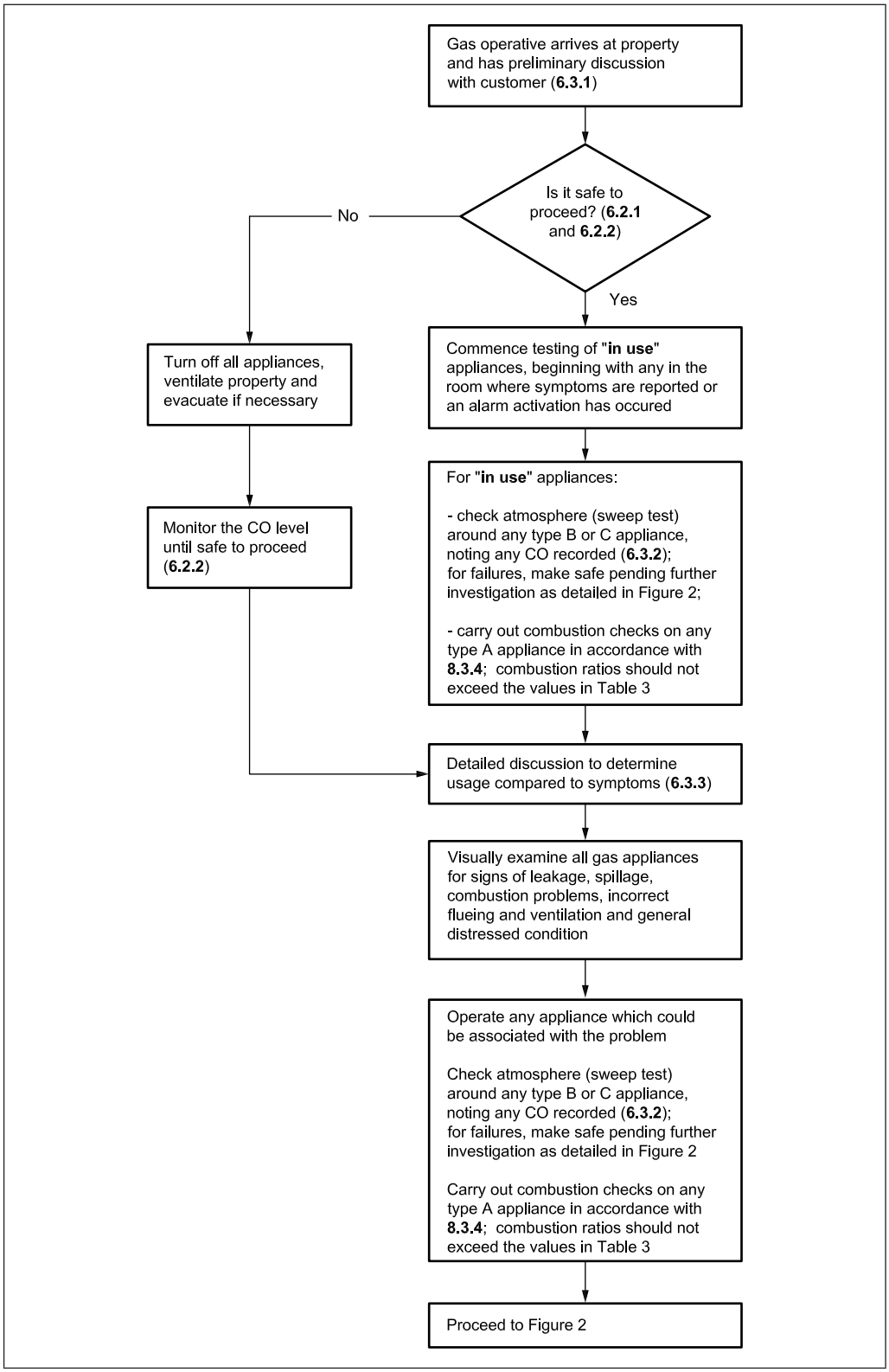
*COMMENTARY ON **6.2.2**b)*
*EH40/2005 Workplace exposure limits [8] allows 15 min exposure to CO at 200 ppm time-weighted average.*

*COMMENTARY ON **6.2.2**c)*
*Open windows and doors to ventilate the dwelling before leaving. On re-entry check the atmosphere in the dwelling continually from the point of access inwards.*

## 6.3 Preliminary procedure for carrying out checks for CO spillage/leakage from gas appliances

*NOTE Proceed as described in Figure 1. More detailed advice is provided by the subclauses and notes referenced in Figure 1.*

Figure 1 **Flow chart of the preliminary procedure for carrying out checks for CO spillage/leakage from gas appliances**



### 6.3.1 Possible circumstance identified by preliminary discussion with customer (see Figure 1)

A gas operative arriving at the site could encounter some of the following:

a) people who have experienced or are experiencing nausea, dizziness, chest pains, headaches and/or palpitations when appliances are or have been in use;

*NOTE Some common illnesses exhibit similar symptoms to those resulting from exposure to CO.*

b) the presence or report of unusual smells, oppressive atmospheres, strange "tastes" and/or condensation when appliances are in use;

c) sooty marks/stains on or around appliances and flues;

d) the presence of CO and/or other fumes/smells;

e) CO detector activation; and

f) referral from ESP or an agent acting on behalf of the customer.

### 6.3.2 Sweep test for open-flue and room-sealed appliances

Prepare the gas analyser as described in **5.2** and set it to measure CO.

With the appliance in operation at full rate, slowly move the sampling probe above, around and below the appliance, keeping the tip approximately 100 mm away from the part of the appliance/chimney system being examined.

This test should last for a minimum of 2 min per appliance, and should include a minimum of two passes around the appliance or chimney/flue.

Ensure that when testing open-flue appliances doors and windows are closed and any fans (including those within other appliances) are in operation.

The test should also be carried out on the joints of any flue connected to the appliance.

Where access to the flue or its joint cannot be gained, the sweep test cannot be relied upon to confirm the flue's integrity.

Ensure the gas analyser returns to zero between tests.

Record the maximum level of CO measured for each test.

*COMMENTARY ON **6.3.2***
*For open-flue appliances give particular emphasis to above and below the edges of any draught diverter. For room-sealed appliances carefully examine entry points for seals, thermocouples, etc. In each case, keep the tip of the sampling probe approximately 100 mm away from the area being examined.*

### 6.3.3 Detailed discussion with customer (see Figure 1)

A discussion with the customer might include the following questions.

a) Does the problem only occur when appliances, including mobile/portable appliances, are or have been in use? Are there any safety warning notices/ labels attached to the installation/appliances?

b) Do customers feel unwell in the property and better when outside or away from the property, and what are their symptoms?

c) Is there a pattern to the occurrences, e.g. observed once, more than once or many times, in what circumstances (such as during particular weather conditions or domestic activities or from the use of a household chemical) or in a particular room?

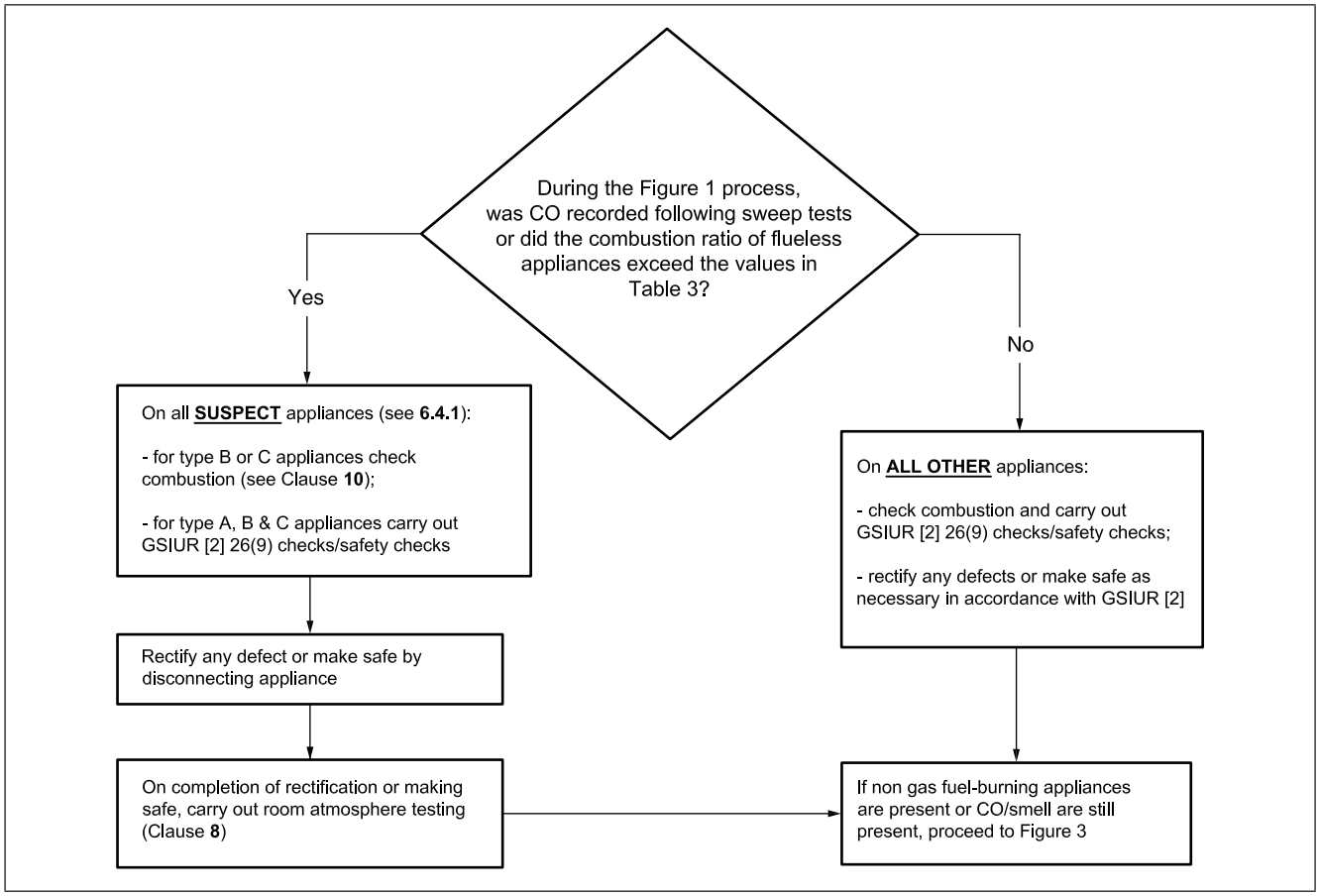
d) Which gas appliances are in use at the time?

e) Are the appliances being used incorrectly, e.g. cooking appliance used to heat room, oversized cooking pots used on cooker, barbeque or patio heater used indoors?

## 6.4 Confirming safe operation of a gas appliance

*NOTE Proceed as described in Figure 2. More detailed advice is provided by the subclauses and notes referenced in Figure 2.*

Figure 2 **Flow chart for confirming safe operation of a gas appliance**




### 6.4.1 Investigation of "suspect" gas appliances

It is essential to investigate all gas appliances initially identified as "suspect" as there could be more than one faulty appliance/installation. The most likely "suspect" appliance should be investigated first before progressively checking other "suspect" appliances.

*NOTE 1 If spillage/leakage is detected from either an open-flue or room-sealed appliance or CO build-up is occurring in the room or space, only operate the suspect appliance for short periods to avoid exposure to potentially harmful combustion products.*

*NOTE 2 Once spillage/leakage has been detected from either an open-flue or room-sealed appliance, or CO build-up in the room or space has been confirmed, unless the investigation requires the maximum CO level to be determined, it is not necessary to continue testing until the maximum level that can be generated in the room or space is confirmed.*

The gas operative should:

a) check the burner operating pressure and/or gas rate and check flame picture following the advice in the gas appliance instructions, and, where possible, check the combustion performance following the advice in the gas appliance instructions or, if the instructions do not contain such advice, use the appropriate method specified in Clause **10**;

b) if the combustion performance ratio ($CO/CO_2$) is greater than allowed in the gas appliance instructions or, if the instructions do not contain such advice, greater than allowed in Table 3, or where it is not possible to check the combustion performance of an appliance, perform a detailed examination in accordance with **6.4.2**;

c) where no spillage/leakage is detected from open-flue and room-sealed appliances and, for all appliance types, the combustion performance ratio is within the limits allowed by the gas appliance instructions or, if the instructions do not contain such advice, within the limits allowed by Table 3, carry out the additional checks in accordance with **6.4.3**; and

d) if no fault can be identified, consider other potential sources of CO or smells as described in **6.6, 8.3.6** and **9.8**.

Table 3 **Combustion performance ($CO/CO_2$ ratio) action levels**

| **Appliance type** | | **$CO/CO_2$ ratio** | **$CO/CO_2$ ratio**<br>**Appliances with air gas ratio control valve** |
|---|---|---|---|
| Back boiler unit | Boiler unit | 0.008 0 | 0.004 0 |
| | In combination with gas fire | 0.020 0 | |
| Central heating boiler | | 0.008 0 | 0.004 0 |
| Circulator | | 0.010 0 | |
| Combination boiler | | 0.008 0 | 0.004 0 |
| Gas fires | Open-flue (type B) | 0.020 0 | |
| | Room-sealed (type C) live fuel effect | 0.020 0 | |
| | Other room-sealed (type C) | 0.008 0 | |
| | Flueless (type A) (NG) | 0.001 0 | |
| | Flueless (type A) cabinet heater (LPG) | 0.004 0 | |
| Water heater: flued and flueless | | 0.020 0 | |
| Warm air heater | | 0.008 0 | 0.004 0 |
| Flueless cookers | Cooker oven | 0.008 0 | |
| | Cooker hob | Assess flame picture | |
| | Cooker grill (CE-marked) | 0.010 0 | |
| | Cooker grill (non CE-marked) | 0.020 0 | |
| Range oven (flued) | | 0.020 0 | |
| Refrigerator (LPG) | | 0.007 0 | |
| Tumble driers | Flued | 0.010 0 | |
| | Flueless | 0.001 0 | |
| Gas lights (LPG) | | 0.020 0 | |

### 6.4.2 Detailed examination

The following list should be observed in full whenever it has not been possible to check the combustion performance ratio ($CO/CO_2$) of a "suspect" appliance in accordance with the appropriate methods in Clause **10**, or when the combustion performance ratio ($CO/CO_2$) is greater than allowed in the gas appliance instructions or, if the instructions do not contain such advice, greater than allowed in Table 3.

*NOTE 1 Further detailed advice for specific gas appliance types is given in **6.5**.*

a) Ensure gas and electrical supplies are isolated.

b) Ensure that all components that could affect combustion are undamaged and replace as necessary.

*NOTE 2 A high combustion performance ratio ($CO/CO_2$) might be due to damage or the ageing of components of the appliance. If this is the case then replace the relevant components and repeat the combustion test. However, certain components contain volatile compounds for which it is necessary to "burn off the newness" before reliable measurements can be obtained. Examples include a gas fire ceramic fibre fuel effect, a cooker grill fret, insulation and adhesives. Consequently, if such a component is fitted as a replacement, it is necessary to burn off the newness before a reliable measurement can be obtained.*

c) Inspect and, if necessary, clean the injectors, venturies, burners, lint guards, air path to the combustion chamber and any other items recommended by the gas appliance instructions.

d) Inspect and clean any pilot/injector.

e) Inspect and, if necessary, clean the heat exchanger, flue hood and flueways, ensuring any baffles, etc., are correctly positioned.

f) Ensure that any seals and fastenings are present, in good condition and secured in accordance with the gas appliance instructions.

g) Reinstate gas and electricity supplies.

h) Ensure the flame picture is satisfactory.

i) Decide if it is possible to carry out a combustion performance test in accordance with Clause **10**.

1) Where it is possible to carry out a combustion performance test, if the test result conforms to the combustion performance ratios allowed in the gas appliance instructions or, if the instructions do not contain such advice, conforms to the ratios allowed in Table 3**,** perform the final checks listed in **6.4.4**.

If the $CO/CO_2$ ratio result is above the limit allowed then recheck steps a) to h). If the combustion ratio is still too high then seek help from the appliance manufacturer.

2) When a new component has been fitted, operate the appliance at full rate. Take a combustion reading at intervals until a satisfactory stable level is reached or the level stabilizes at an unacceptable level. For the latter, if the level does not fall within 20 min, make a further inspection of the appliance to establish the cause of the high reading.

3) Where it is not possible to carry out a combustion performance test, perform the final checks listed in **6.4.4**.

### 6.4.3 Additional checks when combustion performance is satisfactory

Where the detailed examination in **6.4.2** has not been necessary, it is imperative that the following checks are carried out before proceeding to the final checks listed in **6.4.4**.

a) Visually examine appropriate areas of the appliance for signs of spillage, heat stress, corrosion or damage. It might be necessary to remove the outer casing to do this.

b) Replace any parts necessary to restore correct and safe operation.

### 6.4.4 Final checks

The following final checks should be performed before confirming that the gas appliance is no longer "suspect".

a) Check all disturbed gas connections. Test for gas tightness where a gas escape was previously identified/repaired.

b) Confirm that the burner operating pressure and/or gas rate is correct.

c) Where possible, carry out a final combustion performance test in accordance with the methods in Clause **10** to confirm that the combustion performance is within the limits allowed in the gas appliance instructions or, if the instructions do not contain such advice, within the limits allowed in Table 3.

d) Check the operation of any flame supervision device using the manufacturer's approved method.

e) Ensure all seals or fastenings are present, in good condition and secured in accordance with the gas appliance instructions. Be especially vigilant with room-sealed positive fan pressure appliances. Refer to BS 5400-1:2008, Annex E.

f) Where appropriate for the appliance design, carry out a spillage test.

g) Ensure any warning labels necessary to ensure safe use of the appliance are present and correct.

## 6.5 Specific gas appliance considerations

### 6.5.1 General

A gas operative should always exercise judgement when deciding which specific tests and checks are relevant to the particular circumstances of an appliance investigation. Guidance on how to consider this complex range of issues is given in **6.5.2** to **6.5.10** for specific types of appliances.

It is important that the installation of any "suspect" appliance is checked and verified as being in accordance with the gas appliance instructions or the relevant industry and British Standard.

*NOTE A list of relevant standards is given in the Normative references and Bibliography. For natural gas appliances the relevant standard is BS 5440-2 .*

### 6.5.2 Air extraction/circulation systems

Consider the potential effect on flueless and open-flue appliances of any systems that could affect air supply, combustion and flue performance, such as extract fans, recirculation fans, air handling/cooling systems, tumble dryers and passive stack systems. Test any affected appliances in accordance with the gas appliance instructions or the relevant industry standard or BS 5440-1, whichever is appropriate.

### 6.5.3 Flueless (type A)

Ensure that the installation fully conforms to the gas appliance instructions, such as room volume, location, openable windows, permanent ventilation, draughts and labelling.

### 6.5.4 Open-flue (type B)

Check that the flue, including any section in the roof space, is free from defects, is correctly routed and sized, and adequately supported throughout its length. Where a ridge terminal is fitted, check the integrity of the adapter and its fixing bolts. Check the terminal is of a suitable type and the location is acceptable.

*NOTE Where appliances need to be removed for this to be done, it may be carried out at a later stage after the initial appliance tests have been completed.*

Where spillage or flue flow problems are observed, increase ventilation to the room to determine if the problem is related to inadequate ventilation.

Consider external factors that could have an effect on flue performance, for example:

a) topographical features such as hills and large trees, which under some weather conditions can have an adverse effect;

b) domestic wind turbines;

c) short flues; and

d) excessive lengths of external flue pipe in exposed positions, which could suffer chilling.

Consider the potential effect of a restricted air supply to both the combustion chamber area and the flue/draught diverter as a result of inadequate installation clearances.

Consider the potential interaction between flues, particularly long masonry chimneys affecting short flue pipe systems, and the effect of solid fuel appliance operation on an open-flue gas appliance.

### 6.5.5 Room-sealed (type C)

Confirm that all seals, fastenings and the flue assembly are correctly fitted and the appliance is gas tight.

Consider whether the appliance could have been used with the case incorrectly fitted.

For positive pressure appliances, check around the case for air disturbance with a match, taper or smoke generating device other than a smoke pellet. Refer to BS 5400-1:2008, Annex E.

### 6.5.6 Warm air heaters

Check that there is a satisfactory return air path to the main collection area from every room with a warm air outlet, except the kitchen, bathroom and WC.

Where the appliance is open flue, check that there is a positive connection between the return air grille and the appliance and that the grille has not been obstructed, e.g. by clothing.

Check the flame picture with the circulation fan running. If the flames are disturbed check the heat exchanger, the positive return air connection and the integrity of the plenum and all ducting joints, particularly those within any heater compartment.

In the absence of the gas appliance instructions on how to check the integrity of the heat exchanger, use one of the methods published by CORGI*direct* in their *Central Heating Wet and Dry* publication [18].

*NOTE 1 Warm air heaters with heat outputs of less than 25 000 Btu/h (7.33 kW) installed before 1969 were allowed to be installed without a positive return air duct between the heater and return air grille.*

*NOTE 2 Where other open-flue appliances are installed within the collection area or adjacent areas, consider whether the circulation fan could interfere with their flue performance.*

*NOTE 3 Some warm air heaters are provided with a fanned air supply from a ventilated roof space or outside air to the return air duct or return plenum as described in BS 5864.*

### 6.5.7 Fires

Check that the flue is the correct size for the fire.

Examine the catchment space or fire box for correct size, integrity and freedom from debris, ensuring the base of the flue and any fire surround is correctly sealed.

Where the chimney includes precast blocks carry out a visual check, as far as is reasonably practicable, to confirm that the blocks are suitable for the fire connected and are correctly installed, and the joints are soundly made with no excessive mortar protrusions causing a restriction in the flue. Measure the minimum dimensions and calculate the cross-sectional area of the flue and check the gas appliance instructions to ensure that the fire fitted is suitable for use with the flue block size.

Ensure that any damper is removed or locked in the open position in a way that ensures it cannot block the flue.

Ensure that the flue spigot and spigot restrictor are installed correctly.

Ensure that the closure plate is as specified by the manufacturer and sealed to the mounting surface.

Visually examine the heat exchanger for signs of cracks and indication of leakage, e.g. staining.

In the case of a fuel effect gas fire, visually examine the fuel bed to ensure that it has been assembled correctly in accordance with the gas appliance instructions.

### 6.5.8 Fire/back boilers and fire/back circulators

Examine any catchment space for correct size, integrity and freedom from debris, ensuring the following:

a) where a back circulator has been fitted to an unlined chimney, that the flue product outlet connection has been constructed to prevent the entry of falling debris into the appliance flue spigot or flue piece, and that any special flueing arrangements contained in the gas appliance instructions have been followed;

b) where a back boiler has been fitted, that the chimney has been lined; and

c) the liner fitted is either continuous from the appliance to the terminal or, where a short length of either rigid or flexible flue pipe has been used to connect the appliance to the chimney liner, that:

   1) the flue pipe projects at least 150 mm into the liner;

   2) the annular space between the pipe and the chimney liner is sealed in such a way that it does not restrict the flue pipe exit and the seal material will not fall back into the back boiler enclosure;

3) the builder's opening is sealed from any duct constructed to accommodate pipework;

4) the back boiler/circulator enclosure only has two openings: an entrance through and round the back of the fire and an exit via the flue – seal all other openings, in particular gaps/cracks inside the builder's opening (including any in or around any chair-brick), those between any surround and the builder's opening, those which exist in respect of an existing under-floor air supply, and those made for the passage of gas, water, flue pipes and electric cables; and

5) the ventilation has been suitably sized to accommodate the total of the maximum rated heat inputs of the combined fire/back boiler or fire/back circulator in accordance with the relevant industry and British Standards.

*NOTE A list of relevant standards is given in the Bibliography.*

### 6.5.9 Cookers

Confirm that the cooker is fitted in accordance with the cooker instructions, particularly with regard to clearances from obstructions, e.g. a shelf fitted directly above a high level grill. Confirm that the location of any cooker hood or extract fan sited above or adjacent to the cooker/hob is fitted in accordance with the cooker instructions.

Check flame patterns on all burners. Pay particular attention to:

a) flame impingement on the fret and/or fret distortion for grill burner designs that consist of a bar burner firing below a perforated fret;

b) grease spillage on the oven burner; and

c) aeration, damaged burner caps/flame retention components and venturi tube alignment for hotplate burners.

### 6.5.10 Appliances in compartments

When no fault has been found with any appliance carry out a flue performance test in accordance with the appropriate standard, with the compartment door closed, in accordance with **10.4.2.1**.

## 6.6 Check of non-gas appliances and/or for continued smell/presence of CO

*NOTE 1 Proceed as described in Figure 3. More detailed advice is provided by the subclauses and notes referenced in Figure 3.*

*NOTE 2 If the non-gas appliance is a solid fuel appliance then it is likely that the sweep test will only be possible with the appliance in operation as found.*

*NOTE 3 If a non-gas appliance is thought to be the cause of the problem, recommend the customer seek expert advice. For oil appliances, contact the Oil Firing Technical Association (08456 58 50 80, www.oftec.co.uk). For solid fuel appliances, contact the Solid Fuel Association (08456 01 44 06, www.solidfuel.co.uk).*

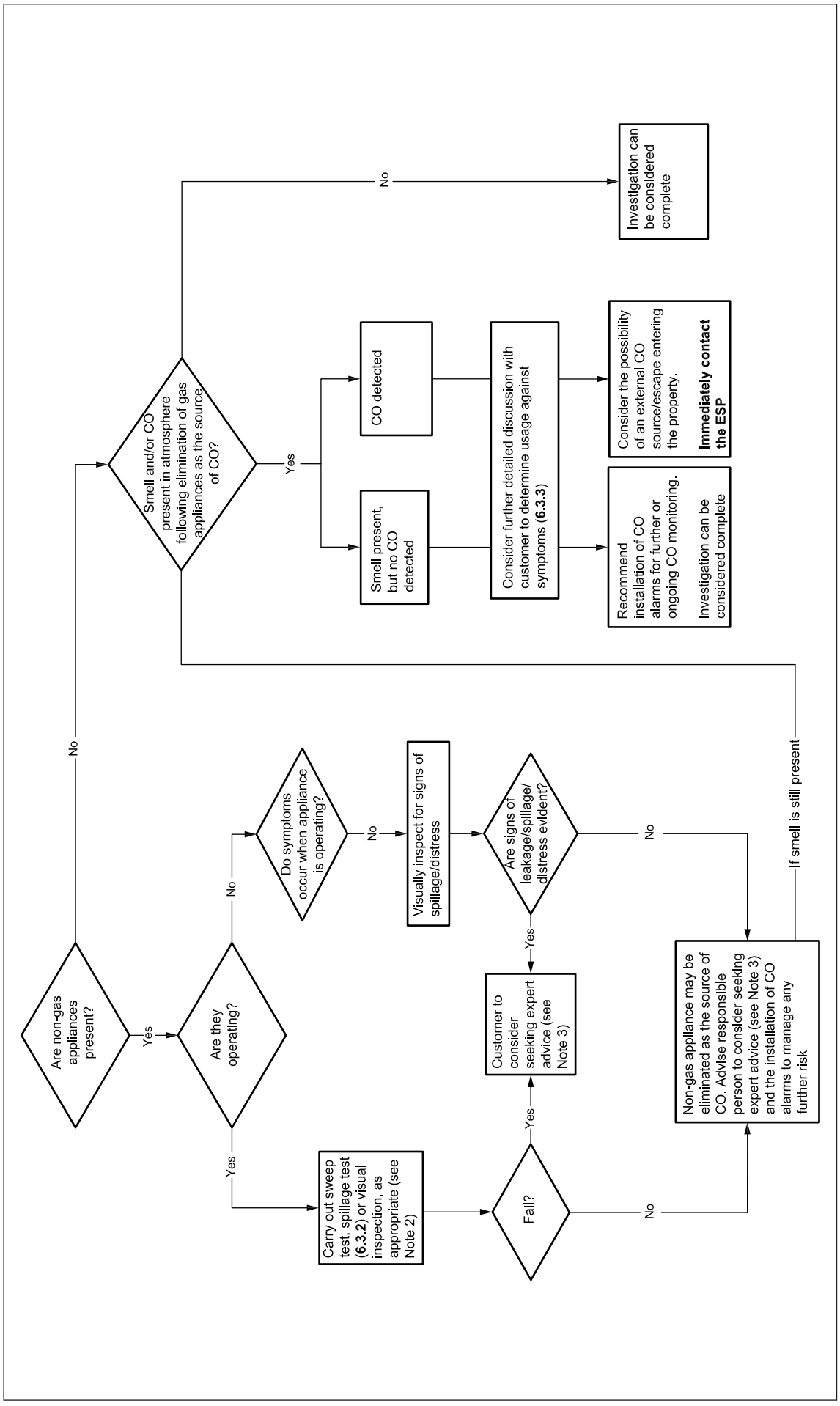



Figure 3 **Flow chart for non-gas appliances and/or continued smell/presence of CO**

# 7 Reacting to activation of CO detectors

## 7.1 General

A customer might be concerned when a CO detector is activated within a property. Such detectors fall into two categories:

a) an electrical CO detector; or

b) a CO indicator card (sometimes called a "spot indicator").

Electrical CO detectors provide both a visual and audible indication (alarm) of excessive CO levels in a property and are either battery-powered or mains-powered.

Indicator cards provide only a visual indication of room atmosphere contamination with CO. On exposure to CO, a sensitive spot changes colour from light brown to black.

Guidance for responding to alarms/alerts given by electrical CO detectors and CO indicator cards is given in **7.2** and **7.3**, respectively.

## 7.2 Electrical CO detector

*NOTE 1 Proceed as described in Figure 4. More detailed advice is provided by the subclauses and notes referenced in Figure 4.*

If an electrical CO detector is installed, confirm whether it has activated, for how long, how frequently and in what circumstances. Check that the detector is working in accordance with the instructions.

*NOTE 2 Detectors will emit a range of differing audible alarm sounds dependent upon particular circumstances.*

If the alarm activation is considered to be indicating the presence of CO, suspect all appliances in the building and use a gas analyser in accordance with Clause **8** to confirm the CO levels. Rectify any faulty appliance installations. If there is no identifiable source of CO within the dwelling, check to establish if the source of the CO is external to the dwelling (see **8.3.6**).

If these checks indicate that no CO is present, suspect that the detector is faulty or has been activated by other products, such as aerosol sprays. This is especially relevant where the customer has suffered no ill effects and where subsequent checks confirm that appliances are operating satisfactorily with no installation faults.

If subsequent investigations suggest a CO level that could have activated the detector's alarm, but there is no evidence that it has been activated, consider that it might be faulty or incorrectly positioned.

For flueless appliances (e.g. cookers), if subsequent investigations suggest a CO level that ought not to have activated the alarm, but there is evidence that it has been activated, consider that the detector might be faulty or incorrectly positioned.

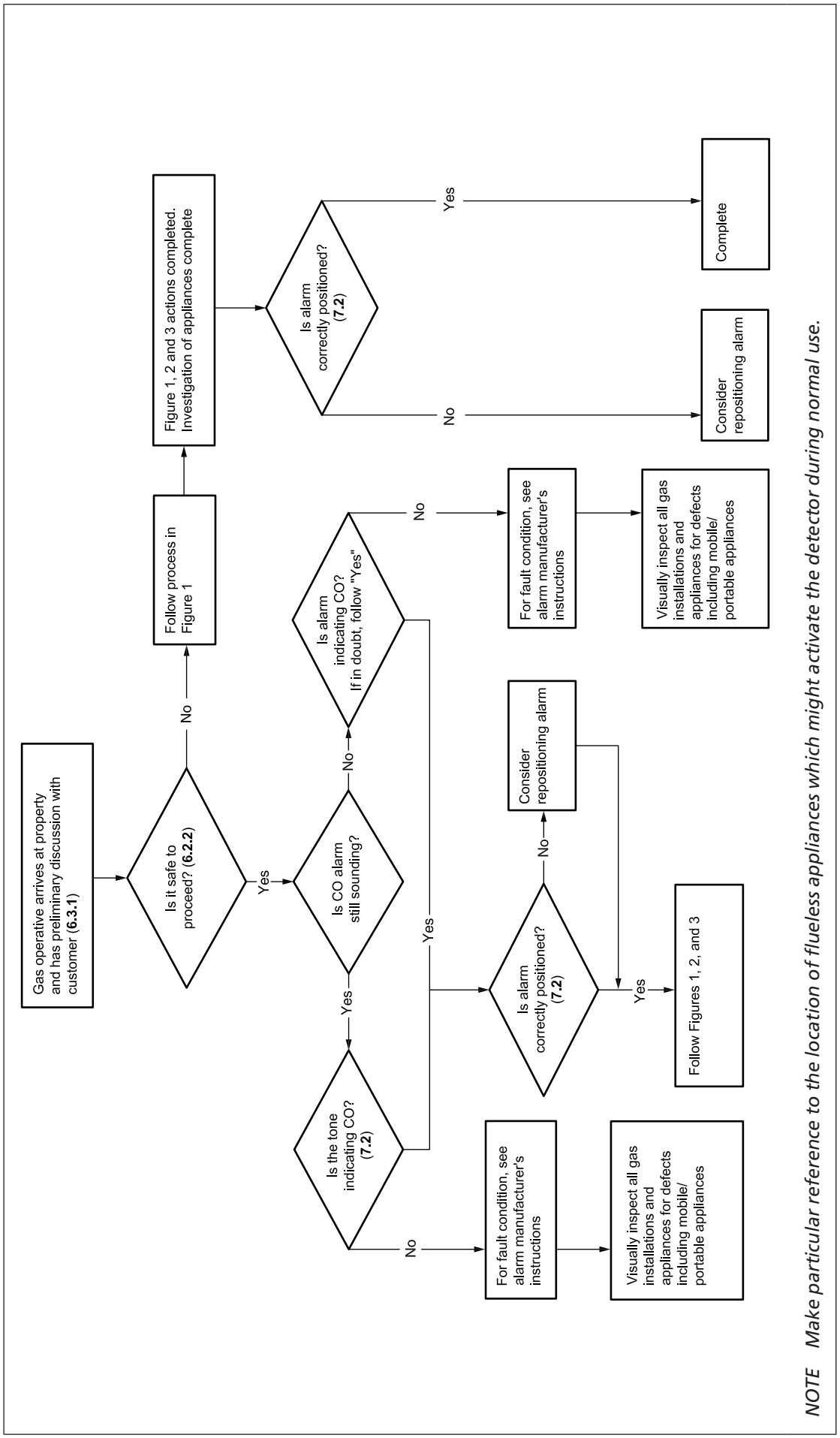
All domestic, electrical CO detectors should conform to BS EN 50291 and be accompanied by full instructions for the location of the detector. If the instructions are not available, refer to BS EN 50292.

In all cases where a faulty detector is suspected, recommend to the customer that it is replaced.

*COMMENTARY ON **7.2***
*Where an independently-mounted carbon monoxide detector to BS 7860 is already in a room containing a gas appliance advise the user that the manufacture of such detectors to BS 7860 ceased in March 2006, by which time all manufacture of such detectors was to the updated requirements of BS EN 50291. With the expected working life of BS 7860 detectors around five years, recommend the user to replace the detector with one manufactured to BS EN 50291.*

Figure 4 **Responding to electrical CO detector (alarm) activations**




*NOTE Make particular reference to the location of flueless appliances which might activate the detector during normal use.*

### 7.3 CO indicator card

When the customer is alerted by an activated CO indicator card, check with him/her how quickly, and in what circumstances, the colour change appeared to take place.

If the indicator card has changed colour, use a gas analyser in accordance with Clause **8** to confirm the CO levels and rectify any faulty appliance installation(s). If there is no identifiable source of CO within the dwelling, check to establish if the source of the CO is external to the dwelling (see **8.3.6**).

If these checks indicate that no CO is present, examine the possibility of other causes for the card changing colour [see item c)]. This is especially relevant where the customer has suffered no ill effects and where subsequent checks confirm that appliances are operating satisfactorily with no installation faults.

Where indicator cards are used they should be positioned in accordance with the indicator card instructions. However, attention is drawn to the following.

a) Indicator cards are not considered suitable as an alarm in sleeping accommodation since they do not provide an audible alarm that could waken a person who is asleep.

b) Most cards have a useful lifespan (normally indicated on the cards), after which they should be replaced.

c) Other products such as aerosol sprays can cause cards to change colour.

## 8 Determining ambient levels of carbon monoxide (CO) in a room

*NOTE When any appliance testing is undertaken, for the basic safety rules, see **6.2.1**.*

### 8.1 General advice on measurement procedures

The procedures described in **8.3** are not intended to measure the absolute levels of CO within a space. They are intended to measure the increase in CO level (which, for example, could come from a faulty appliance installation) above the outdoor background CO level.

If an absolute CO level is required it is necessary to "zero" the gas analyser with a CO-free sample. If the gas analyser measures absolute CO levels it is necessary to subtract the outdoor background CO level from the level recorded in the building.

There are many types of gas analyser and this standard can only provide general advice. For some gas analysers that always commence their measurement from a position of absolute zero it is not necessary to "zero" in the outdoor air. The gas analyser instructions should always be consulted and followed.

Busy roads and car park exits can generate significantly high levels of outdoor background CO and this should be kept in mind when forming the final conclusion to the test.

Possible reasons for testing for CO are given in **6.3.1**.

*COMMENTARY ON **8.1***
*In some circumstances the monitoring of $CO_2$ levels can give a better indication of the presence of combustion products. This is particularly true where the volume of combustion products released is small, the concentration of CO in the combustion products is low or access to the appliance is restricted, e.g. when appliances are fitted in small appliance compartments. Where $CO_2$ is used to check for the presence of combustion products, as a precaution it is essential that CO is monitored because of its greater toxicity.*

*The CO levels measured in accordance with **8.3** are increases above outdoor background conditions.*

*Outdoor background levels of CO rarely exceed 2 ppm. However, the levels can be significantly higher, e.g. near a very busy road or garage.*

*The methods described in **8.3** are appropriate for detecting sources of CO so that action can be taken to rectify faults. However, in instances where an absolute measurement is required, the readings obtained using **8.3** might not be valid when judging whether levels of CO are a hazard to health.*

## 8.2 Preparation for CO build-up testing

It is recommended that only persons required to carry out the test work are in the room under test and that these persons do not smoke before or during the tests. Smoking in other parts of the building adjacent to the area being tested should be discouraged during the testing procedure as this can also adversely affect results.

Position an open-ended sampling probe approximately 2 m above floor level in the centre of the room and at least 1 m away from any suspect appliance installation.

Turn off/extinguish all combustion appliances and ventilate the room until the inside and outside CO levels are the same.

Close all external doors, windows and customer-adjustable ventilation. Record the level of CO over a 15 min period. If the indoor level of CO starts to rise during this period, check for CO migration from other sources. If there is no rise then proceed to the appropriate test in **8.3**.

*NOTE 1 There might be more than one appliance installation at fault and more than one source of CO in the building. CO can come from sources other than gas appliances, e.g. solid fuel appliances, smoking.*

*NOTE 2 For the basic safety rules to be followed by the operative, see **6.2.1**.*

*NOTE 3 Information on sources of CO and its movement is given in **9.7** and Annex B.*

## 8.3 Testing procedures

### 8.3.1 General

With the suspect appliance(s) operating one at a time, measure the CO level in the room in accordance with **8.3.2**, **8.3.3** or **8.3.4** depending on what type of appliance(s) is being operated.

Clearly record the CO level measurements and make the results available in accordance with Clause **14**.

*NOTE The generation of negative pressures within spaces might prevent the correct operation of combustion and flue systems or induce CO from other spaces. Consequently, for each test it is necessary to take account of the effect of mechanical air movement and extraction equipment such as cooker hoods, extractor fans, radon ventilation systems, tumble dryers, warm air circulation fans and appliance flue interaction between rooms.*

Except when carrying out the test for cookers in accordance with **8.3.4.1**, when higher intermittent levels are allowed, if at any time the CO reading exceeds 30 ppm, stop the test, turn off all appliances, open all windows and doors to ventilate the room, and vacate the room under test.

If the CO reading exceeds the level(s) given in **9.3**, perform the appropriate action recommended in **9.3**.

### 8.3.2 Room-sealed (type C) appliances

Operate the appliance at full rate until the CO reading stabilizes or begins to fall, whichever occurs first.

*NOTE The instructions of some boilers fitted with an air gas ratio control valve require the appliance combustion to be checked at full and low rate.*

### 8.3.3 Open-flue (type B) appliances

Operate the appliance at full rate until the CO reading stabilizes or begins to fall, whichever occurs first.

### 8.3.4 Flueless (type A) appliances

#### 8.3.4.1 Cookers

Ensure that all permanent ventilation to the space in which the appliance is situated is unobstructed.

Place a saucepan on each of the pan-supports above the two largest hotplate burners, put approximately 1 L of water in each, and cover with a lid. Use a saucepan with a flat base and a base diameter of between 160 mm and 220 mm. Place the grill pan in its highest position under the grill.

Open/operate the customer-adjustable ventilation in accordance with the cooker instructions, e.g. window or extractor fan.

Light the grill, oven and the two hotplate burners at their maximum setting. Turn the oven down to gas mark 5 (or mid-range if not calibrated in gas mark numbers).

Record the CO levels at 1 min intervals.

Turn the hotplate burners down to simmer when the water boils. Turn the grill off after 30 min.

If during the test the CO reading:

a) begins to fall without exceeding 30 ppm, stop the test – the installation and cooker are satisfactory;

b) does not exceed 30 ppm for longer than 20 min and begins to fall and does not exceed 90 ppm at any time, stop the test – the installation and cooker are satisfactory;

c) exceeds 90 ppm at any time, stop the test, ventilate the room, identify the cause, rectify and repeat the test.

*NOTE 1 Do not allow the saucepans to boil dry.*

*NOTE 2 This method is also intended for "built-in" gas cooking appliances.*

*NOTE 3 Where not all burners can be operated together due to appliance design or for mixed fuel appliances, use only those burners that are applicable.*

#### 8.3.4.2 Flueless water heaters

Ensure that all permanent ventilation to the space in which the appliance is situated is unobstructed. Close all customer-adjustable ventilation to the space in which the appliance is situated.

Light the appliance and operate it at maximum gas rate for 5 min, recording the CO levels at 1 min intervals.

*NOTE A period of 5 min is sufficient as flueless water heaters are normally required to have a label attached in a prominent place, advising that the water heater is not to be used continuously for more than 5 min. The Commentary and Recommendations on BS 5546:2010, **5.3.2**, refer to this matter.*

#### 8.3.4.3 Flueless space heaters

Ensure that all permanent ventilation to the space in which the appliance is situated is unobstructed. Close all customer-adjustable ventilation to the space in which the appliance is situated.

Light the appliance and operate it at maximum gas rate for 30 min, recording the CO levels at 1 min intervals.

*NOTE This appliance category encompasses liquefied petroleum gas (LPG) cabinet heaters with or without a catalyst and natural gas and LPG fixed space heaters with or without a catalyst.*

### 8.3.5 Additional considerations

Where chimneys or flues pass through other rooms, spaces or properties, e.g. from living room to bedroom, the test described in **8.2** should be repeated in the "other room", "property" or living area adjacent to the "space", ensuring the appropriate appliance(s) is (are) operating as described in **8.3.2** and/or **8.3.3**, as relevant. Where a concealed flue is present the void through which it passes should be checked, where access can be gained.

*COMMENTARY ON **8.3.5***
*If there is doubt as to the robustness of a concealed chimney/flue system, the Gas Industry Unsafe Situations Procedure [1] provides guidance on risk classification.*

### 8.3.6 Identifying external sources of CO

If there is no identifiable source of CO within the dwelling, turn off all appliances, open all windows and external doors, and repeat the procedures in **8.3.2** to **8.3.4**, moving the test probe around the room until the entry point is established. The entry point can be at any position within the room.

Perform the test throughout the dwelling until the source or entry point of CO is established.

Having established the entry point and source of CO, it is essential to take the following action as appropriate.

a) If the source of CO is a gas appliance, refer to Regulation 34 of the Gas Safety (Installation and Use) Regulations [2]. When remedial work cannot be carried out, follow the guidance given in the *Gas Industry Unsafe Situations Procedure* [1].

   *NOTE 1 Guidance on Regulation 34 is contained in the Health and Safety Executive (HSE) Approved Code of Practice and Guidance, Safety in the installation and use of gas systems and appliances [11].*

b) If the source of the CO is an appliance other than a gas appliance, advise the customer to seek the relevant expert advice.

   *NOTE 2 For oil appliances the contact is the Oil Firing Technical Association (08456 58 50 80, www.oftec.co.uk). For solid fuel appliances contact the Solid Fuel Association (08456 01 44 06, www.solidfuel.co.uk).*

c) If the source is a landfill site, inform the local authority environmental health department. If drainage is the suspected source, inform the water undertaker.

If the source of CO cannot be determined, notify the National Gas Emergency Service.

# 9 Information on levels of CO

## 9.1 General

Higher levels of CO than those that equate to an 8 h time-weighted average of 10 mg/m$^3$ (equivalent to 9 ppm) are not acceptable.

*NOTE 1 The World Health Organization (WHO) Air Quality Guidelines for Europe [19] recommends an 8 h time-weighted average of 10 mg/m$^3$ for CO concentrations in outdoor air. These guidelines have been recommended for CO concentrations in indoor air by the Department of Health's Committee on the Medical Effects of Air Pollutants [20] and so have also been adopted in this standard. This means that the general population, which includes sensitive individuals, can be exposed to a concentration of 10 mg/m$^3$ for 8 h without any known health risk.*

With the exception of gas cookers (see Note 3 of **6.2.2**), for practical purposes any concentrations in excess of 10 ppm should not be considered acceptable. Averaging time for concentrations of CO greater than 10 ppm should not be attempted.

*NOTE 2 Although short-term exposure to higher concentrations of CO can be tolerated, the exposure time decreases rapidly with increasing concentrations of CO.*

## 9.2 Additional information on levels of CO for gas cookers

Gas cookers can produce concentrations of CO in excess of 10 ppm for short periods of time, particularly grills on initial ignition. Such concentrations may be allowed, provided the cooker conforms to the guidance in **8.3.4.1** and is installed in accordance with the cooker instructions and BS 6172.

*NOTE The tests on cookers in **8.3.4.1** have been designed to ensure that the short-term exposure to higher concentrations of CO does not exceed an 8 h weighted average of 10 ppm.*

## 9.3 Responding to CO levels

When investigating reports of fumes, smells or CO detector activation, if the presence of CO is confirmed, follow the advice in a), b) or c) for the relevant CO level.

**a) CO levels less than 10 ppm**

At these levels the source of CO could be common activities, e.g. cigarette smoke, cooking or vehicle exhaust gases.

If the source of the CO is other than a gas appliance, see **9.4** or **9.5**.

If the increase in CO is associated with the use of any gas appliance other than a cooker, then the installation should be further investigated and, where necessary, remedial work carried out.

*NOTE 1 Further guidance on CO levels from gas cookers is given in **9.1** and **9.2**.*

If the source can be attributed to the normal function of the appliance, e.g. intermittent flue spillage on a windy day, and there is no potential for greater levels of CO, then levels of CO within this range may be deemed acceptable. However, in coming to this judgement, due regard should be paid to the possible exposure time of the occupants and the guidance in **9.1**.

**b) CO levels from 10 ppm to 30 ppm**

If the source of the CO is other than a gas appliance, see **9.4** or **9.5**.

If the source of CO cannot be determined, notify the emergency services such as fire and/or police.

If the source of the CO is associated with a gas appliance other than a cooker, remedial work should be carried out and assessed in accordance with **9.3**a).

If the source of CO is associated with a gas cooker and it conforms to **8.3.4.1**a), the cooker is satisfactory. If it does not conform to **8.3.4.1**a) the installation should be treated in accordance with **9.3**c) for CO levels greater than 30 ppm.

When remedial work on the gas appliance cannot be carried out, it should be classified as "Immediately Dangerous", as defined in the *Gas Industry Unsafe Situations Procedure* [1] and the guidance given in the current *Gas Industry Unsafe Situations Procedure* [1] should be followed.

*NOTE 2 Attention is drawn to Regulation 34 of the Gas Safety (Installation and Use) Regulations [2]. Guidance on Regulation 34 is contained in the Health and Safety Commission (HSC) Approved Code of Practice and Guidance, Safety in the installation and use of gas systems and appliances [11].*

**c) CO levels greater than 30 ppm**

Except where the CO level is due to performance of a gas cooker in accordance with **8.3.4.1**b), for all CO sources with levels greater than 30 ppm, advise the occupants to leave the dwelling immediately.

Turn off or extinguish all appliances and open windows and doors to ventilate the dwellings, before leaving.

On re-entry, check the atmosphere in the dwelling continually from the point of access inwards.

Do not consider the dwelling safe to fully re-enter to carry out any further investigation until CO concentrations are below 10 ppm, and preferably down to outdoor background levels.

Carry out any investigation in accordance with **6.3**.

Determine the source of CO and, if associated with a gas appliance, classify it as "Immediately Dangerous" as defined in the *Gas Industry Unsafe Situations Procedure* [1].

When remedial work cannot be carried out, follow the guidance given in the current *Gas Industry Unsafe Situations Procedure* [1].

*NOTE 3 Attention is drawn to Regulation 34 of the Gas Safety (Installation and Use) Regulations [2]. Guidance on Regulation 34 is contained in the Health and Safety Commission (HSC) Approved Code of Practice and Guidance, Safety in the installation and use of gas systems and appliances [11].*

If the source of the CO is other than a gas appliance, see **9.4** or **9.5**.

If the source of CO cannot be determined, notify the emergency services, such as fire and/or police.

## 9.4 CO from appliances other than gas appliances

If the source of the CO is an appliance other than a gas appliance, the customer should be advised to seek the relevant expert advice.

*NOTE For oil appliances the contact is the Oil Firing Technical Association (08456 58 50 80, www.oftec.co.uk). For solid fuel appliances contact The Solid Fuel Association (08456 01 44 06, www.solidfuel.co.uk).*

## 9.5 CO from sources other than appliances

If the source of the CO is a landfill site, the local authority environmental health department should be informed. If drainage is the suspected source, the water undertaker should be informed.

## 9.6 References to information on the effects of CO

Information on the effects of CO can be found in:

a) the Department of Health's *Handbook on air pollution and health* [21];

b) the Institute of Environment and Health's *IEH assessment on indoor air quality in the home (2): Carbon monoxide* [9]; and

c) the Health and Safety Executive's guidance note, *Carbon monoxide: Health hazards and precautionary measures* [22].

## 9.7 Movement of CO

Consider the possibility of CO being carried around the dwelling via rising warm air or combustion products. CO could be present in rooms containing no fuel-burning appliances or flue systems, especially in upper storeys, as a result of tracking through pipe ducts, suspended wooden floors or false chimney breasts.

*NOTE For further information on the movement of CO in buildings refer to Annex B.*

Be alert to the possibility of CO entering the property from adjacent properties or re-entry from flue outlets, even where the terminal positions conform to appropriate standards.

Consider the potential for different weather conditions to adversely affect the flue and/or appliance performance.

Extended flues and/or special flue terminals on adjacent properties can be an indication of a "local" problem.

If in doubt about spillage or leakage from flued appliances seek additional technical support from the appliance manufacturer.

Where it is not practicable to correct all situations that are not to current standards, it is essential to take great care in exercising a judgement to reinstate the installation. In these cases the advice given in the *Gas Industry Unsafe Situations Procedure* [1] should be followed.

## 9.8 Generation of CO, smells and fumes when no fault with gas installation

Where no faults have been found with the gas installation, consider the possibility of:

a) CO generation from:
   1) smoking;
   2) other fuel-burning appliances in the dwelling;
   3) vehicles or generators in attached buildings/dwellings; and
   4) engines, e.g. on boats; and

b) potential causes of smells and fumes from:
   1) gas escapes on appliances;
   2) poorly cured fibreglass log effects;
   3) paint smells, particularly on new appliances;
   4) dust on appliance surfaces;
   5) recent cavity wall insulation;
   6) recent painting and decorating activity;
   7) use of solvents and adhesives;

8) damp proofing or timber treatment;
9) outside the dwelling, such as barbecues or bonfires; and
10) drains.

# 10 Determination of the combustion performance of an appliance

*NOTE Gas analysers covered by the scope of this standard are not to be used to identify the point of leakage of combustion products from the appliance combustion circuit, except as detailed in **6.3.2** or where their use for this purpose is detailed in the gas appliance instructions.*

## 10.1 Types of gas-fired appliance

The three types of gas-fired appliances are classified in PD CEN/TR 1749 and BS 5440-1. For a complete description, see **3.21**.

*NOTE Even where there is purpose-built extraction direct to the outside of the building, flueless appliances release some CO and $CO_2$ into the building. The other types of appliance, when installed and operating in accordance with the gas appliance instructions, vent their combustion products into the flue.*

## 10.2 General procedures

The gas analyser should be switched on and prepared for use in accordance with the gas analyser instructions (see **5.2** for guidance on preparation).

If the gas appliance is provided with a sampling point, and a sampling procedure is given in the gas appliance instructions, combustion checks should be carried out in accordance with the appliance instructions.

If specific guidance on carrying out combustion checks is not provided in the gas appliance instructions, the relevant procedure in **10.4** should be used.

For open-flue appliances, to obtain a well-mixed representative sample, the probe tip should be positioned at least 200 mm into the secondary flue.

Ensure that the sampling tube from the sample probe to the gas analyser is free from leaks and damage.

For room-sealed appliances, the sample probe should be positioned 200 mm inside the combustion products outlet duct.

For appliances fitted to SE ducts or U ducts, the air for combustion in the duct might contain variable amounts of combustion products from other appliances. Any combustion products readings cannot, therefore, be relied upon as an accurate indication of combustion performance.

*NOTE 1 Further information can be found in BS 5440-1 and IGEM/UP/17 [23].*

With some appliances, due to where they are sited (e.g. a room-sealed appliance installed in a block of flats and not having a purpose-designed sampling point), it is not possible to gain access to the flow of combustion products in the flue. In such instances it is not possible to measure the combustion products.

Where it has not been possible to check the combustion performance ratio ($CO/CO_2$), refer to **6.4.2** for guidance.

*NOTE 2 Care needs to be taken when sampling in the outlet of a fanned flue appliance to ensure that the probe does not damage the fan.*

When sampling, the position of the probe should be adjusted until the highest steady value of $CO_2$ or lowest steady value of $O_2$ is obtained.

When using a multi-hole sampling probe care should be taken to ensure all of the open sampling holes in the probe are positioned within the combustion products stream in order to obtain the maximum $CO_2$ or minimum $O_2$ reading.

The $CO/CO_2$ ratio should be recorded when the appliance or burner (whichever is applicable) has been operating at the maximum rated input for 30 min, or when the reading is steady, or satisfactory and is decreasing, whichever is the least time, unless stated differently in the gas appliance instructions.

*NOTE 3 The instructions of some boilers fitted with an air gas ratio control valve require the appliance combustion to be checked at full and low rate.*

If the appliance instructions do not give guidance on the required satisfactory $CO/CO_2$ ratio for the appliance being examined then use the satisfactory $CO/CO_2$ ratios given in Table 3. If the $CO/CO_2$ ratio is unsatisfactory then the appropriate action recommended in Clause **12** should be carried out.

It should be noted that certain components contain volatile compounds for which it is necessary to "burn off the newness" before reliable measurements can be obtained. Examples include a gas fire ceramic fibre fuel effect, a cooker grill fret, insulation and adhesives. Consequently, if such a component is fitted as a replacement it is also necessary to burn off the newness before a reliable measurement can be obtained.

It is recommended that when a new component has been fitted, the appliance is operated at full rate and a combustion reading taken after 10 min. If the reading is unacceptable or still rising, monitor at 20 min intervals until a satisfactory stable level is reached or the level stabilizes at an unacceptable level. For the latter, if the level does not fall within 20 min, then a further inspection of the appliance should be made to establish the cause of the high reading.

## 10.3 Sample probes

For many applications the open-ended sampling probe and connection tubing usually supplied with a gas analyser are suitable for collecting a thoroughly mixed and representative sample of the combustion products. However, where this type of probe is not available or flexible enough to gain sufficient access, it is recommended that the probe is open-ended and made from 6 mm outside diameter (OD) malleable metallic tubing approximately 500 mm in length.

Examples of multi-hole probes are described in Annex C. These may be supplied by the gas analyser manufacturer.

## 10.4 Sampling procedure

### 10.4.1 Flueless (type A) appliances

#### 10.4.1.1 Gas cookers

##### 10.4.1.1.1 Grill

The probe should be positioned in the combustion products stream. Where the appliance design allows, the probe and its position should be as shown in Figure C.1.

If the design does not permit the position shown in Figure C.1 (e.g. where the combustion products exit via a vertical grille on the front of a built in cooker), the sampling probe shown in Figure C.2 should be positioned close to the combustion products outlet duct, in the combustion products stream. If the sampling probe shown in Figure C.2 is used, its position should be adjusted until the highest steady value of $CO_2$ or lowest steady value of $O_2$ is obtained.

The grill pan should be in position at the highest level allowed by the cooker instructions during the test.

**10.4.1.1.2 Oven**

If the design permits (e.g. where the combustion products exit via a vertical grille on the front of a built in cooker), the sampling probe shown in Figure C.2 should be positioned close to the combustion products outlet duct, in the combustion products stream.

Where the design does not permit, an open-ended sampling probe should be used, positioned within the oven combustion products outlet duct, in the combustion products stream.

Whichever sampling probe is used, its position should be adjusted until the highest steady value of $CO_2$ or lowest steady value of $O_2$ is obtained.

**10.4.1.1.3 Griddles and covered burners**

For griddles and covered burners an open-ended sampling probe should be positioned in the combustion products stream and should be adjusted until the highest steady value of $CO_2$ or lowest steady value of $O_2$ is obtained.

**10.4.1.1.4 Uncovered hotplate burners**

The design of uncovered hotplate burners does not permit tests to be carried out without specialized equipment usually only available in a laboratory.

Ensure the burners and pan supports are of a type approved by the cooker manufacturer, correctly fitted and not damaged, and the burner ports are not obstructed by cooking or cleaning residue. Incorrect or damaged parts should be replaced.

Visually confirm that the flame picture is satisfactory.

*NOTE If the only damage to the burner and pan supports is cosmetic, e.g. chipping of the enamel, this does not warrant further corrective action.*

### 10.4.1.2 Refrigerators

An open-ended sampling probe should be used, positioned within the combustion products outlet duct, in the combustion products stream.

### 10.4.1.3 Gas lights

The probe should be positioned in the combustion products stream.

### 10.4.1.4 Flueless space heaters

**10.4.1.4.1 Fixed flueless space heaters**

The sampling probe shown in Figure C.2 should be positioned in the combustion products stream directly above the outlet grille. The position of the probe should be adjusted until the highest steady value of $CO_2$ or lowest steady value of $O_2$ is obtained.

**10.4.1.4.2 Mobile portable liquefied petroleum gas (LPG) heaters**

The heater should be in a draught free area and the sampling probe shown in Figure C.2 should be positioned in the combustion products stream directly above the outlet grille. The position of the probe should be adjusted until the highest steady value of $CO_2$ or lowest steady value of $O_2$ is obtained.

#### 10.4.1.5 Flueless water heaters

The sampling probe shown in Figure C.2 should be positioned in the combustion products stream directly above the outlet grille. The position of the probe should be adjusted until the highest steady value of $CO_2$ or lowest steady value of $O_2$ is obtained.

### 10.4.2 Open-flue (type B) appliances

#### 10.4.2.1 Appliances in compartments

The combustion performance of open-flue appliances installed in compartments requires the combustion products to be sampled with the installation operating as normal, i.e. operating so that the open servicing access to the compartment does not provide a greater level of ventilation than usual. Sampling should therefore take place with any door to the compartment closed.

One method of sampling is with the tubing connected between the combustion analyser and the sampling probe in the flue passing via permanent ventilation openings associated with the installation. This then enables the readings to be taken from outside the compartment.

The general procedures to be adopted when sampling different types of appliances in compartments are those outlined in **10.4.2.2** and **10.4.2.3**.

#### 10.4.2.2 Boilers and water heaters

##### 10.4.2.2.1 Boilers and water heaters whose flue system incorporates a draught diverter

An open-ended sampling probe should be positioned in the combustion products stream of the secondary flue via the draught diverter. A multi-hole sampling probe conforming to Figure C.2 can also be used. Whichever probe is used its position should be adjusted until the highest steady value of $CO_2$ or lowest steady value of $O_2$ is obtained.

##### 10.4.2.2.2 Boilers and water heaters whose flue system does not incorporate a draught diverter

An open-ended sampling probe should be placed within the combustion products outlet duct and its position adjusted until the highest steady value of $CO_2$ or lowest steady value of $O_2$ is obtained.

#### 10.4.2.3 Combined warm air heater/circulator water heater

For a combined warm air heater/circulator water heater an open-ended sampling probe should be used, positioned in the combustion products stream of the secondary flue, normally via the draught diverter, and its position adjusted until the highest steady value of $CO_2$ or lowest steady value of $O_2$ is obtained.

The sampling position for both the warm air heater and circulator water heater should be as described in **10.4.2.4**.

Combustion samples should be taken for both the warm air heater and water heater circulator when operating separately and together at full gas rate.

*NOTE The warm air heater and circulator water heater have different combustion performance (CO/CO2 ratio) action levels (see Table 3). The warm air heater has an action level of 0.008 0 and the circulator has an action level of 0.010 0. Care is necessary when combustion samples are taken when operating together in the event that the trigger values have been exceeded, to identify which appliance requires the appropriate corrective action.*

#### 10.4.2.4 Warm air heaters

How the measurements are carried out for warm air heaters depends on the flue/draught diverter configuration. Typical open-flue/draught diverter configurations for air heaters are shown in Figure D.1a) to Figure D.1e).

Normally, an open-ended sampling probe should be used, positioned in the combustion products stream of the secondary flue via the draught diverter, and its position adjusted until the highest steady value of $CO_2$ or lowest steady value of $O_2$ is obtained.

In all installations of appliance types shown in Figure D.1d) and Figure D.1e) access to the combustion products stream is possible from the front of the appliance.

Depending on the installation, appliance types shown in Figure D.1b) and Figure D.1c) have one of three types of access to the combustion products stream: free access, limited access and no access, with the standard probe supplied by the gas analyser manufacturer.

For installations of appliance type shown in Figure D.1a) there is free access or limited access to the combustion products stream.

Where there is only limited access this can require the removal of a slot fit panel or closure panel to gain access to the draught diverter.

For installations of open-flue appliance type shown in Figure D.1h) a purpose-made access point might be provided.

Where there is no access it is not possible to measure the combustion products. Refer to **6.4.2** for guidance.

#### 10.4.2.5 Gas fires

A sampling probe conforming to Figure C.2 should be used where practical. If not, an open-ended probe can be used.

The sampling probe should be positioned at least 200 mm up inside the flue in the combustion products stream and as far away from the burning gas as practicable.

The position of the sampling probe should be adjusted until the highest steady value of $CO_2$ or lowest steady value of $O_2$ is obtained.

If the chosen probe cannot be positioned in the combustion products stream without first removing the fire, e.g. a box-radiant fire, then it is not possible to obtain a reliable combustion sample for the fire as found. Consequently, if the probe cannot be positioned without removing the fire, this test should not be carried out. Refer to **6.4.2** for guidance.

#### 10.4.2.6 Combined gas fire/back boiler units (BBUs)

An open-ended sampling probe should be inserted into the combustion products stream in the secondary flue via the draught diverter. With the appliance fully assembled the combustion products samples should be taken for both the boiler and the fire, when operating separately and together.

It might be necessary to remove the outer case of the fire unit to gain access. If it is still not possible to position the sampling probe correctly when the case of the fire unit has been removed then this test cannot be carried out. Refer to **6.4.2** for guidance.

*NOTE The connecting tube to the sampling probe needs to be routed so that the fire front can be replaced without displacing the probe.*

### 10.4.3 Room-sealed (type C) appliances

#### 10.4.3.1 General

An open-ended sampling probe should be positioned 200 mm inside the combustion products outlet duct and its position adjusted until the highest steady value of $CO_2$ or lowest steady value of $O_2$ is obtained.

*NOTE Care needs to be taken when sampling in the outlet of a fanned flue appliance to ensure that the probe does not damage the fan.*

#### 10.4.3.2 Warm air heaters

Without a custom-made probe (see **10.3**), it is not possible to gain access to the combustion products stream for installations of appliance types shown in Figure D.1f) and it is not advisable to attempt to do so. Refer to **6.4.2** for guidance.

For installations of appliance type shown in Figure D.1g) access can be achieved via the terminal, but only at a safe working height.

*NOTE This type of appliance has not been manufactured since about 1990.*

Room-sealed appliance types shown in Figure D.1h) might have a sampling position fitted.

## 11 Procedure for commissioning, servicing and maintenance using a gas analyser

### 11.1 General

**11.1.1** A gas analyser may be used in connection with the commissioning, servicing and maintenance of a gas appliance:

a) as part of the commissioning process, in accordance with the gas appliance instructions, to confirm the safe and efficient operation of the appliance, e.g. to confirm the integrity of the whole flue system of a room-sealed boiler (see **11.2**);

b) to determine the level of servicing required, i.e. whether the combustion is satisfactory such as to permit servicing in accordance with the gas appliance instructions to be deferred for a further 12 months (see **11.3** and Figure 5);

*NOTE 1 Background to the use of a gas analyser in regular servicing can be found in Annex E.*

c) to confirm satisfactory combustion following servicing in accordance with the gas appliance instructions (see **11.4** and Figure 6); and

d) to confirm satisfactory combustion following maintenance (see **11.5** and Figure 7).

*NOTE 2 It is essential to consult the gas appliance instructions as they might specify particular requirements for individual appliances. Some appliance instructions specify particular combustion requirements ($CO_2$, $O_2$, CO or $CO/CO_2$ combustion ratio).*

**11.1.2** A gas analyser should not be used for appliances fitted to SE ducts or U ducts. Where an appliance is fitted to a SE duct or U duct, the appliance should be serviced in accordance with the gas appliance instructions which often necessitates a full strip and clean.

*NOTE Gas analysers are not to be used for appliances fitted to SE ducts or U ducts because the air for combustion in the duct contains variable amounts of combustion products from other appliances. Any combustion products readings cannot, therefore, be relied upon as an accurate indication of combustion performance.*

## 11.2 Confirmation of safe and/or efficient operation at the time of commissioning

A gas analyser may be used to confirm the safe and/or efficient operation of an appliance at the time of commissioning only when the gas appliance instructions:

a) require this;

b) provide detailed instruction on how to carry out the checks;

c) specify the acceptable/unacceptable combustion values; and

d) in the event of an unacceptable combustion value, provide information as to what corrective action is to be carried out.

If, either due to the absence of the necessary equipment or through lack of expertise, the gas appliance instruction's methods and figures cannot be applied, the appliance should be turned off, disconnected and labelled as an uncommissioned appliance until such time as either the necessary equipment and/or expertise is available.

## 11.3 Determination of the level of servicing required and subsequent actions (see Figure 5)

**11.3.1** A gas analyser may be used to determine the level of servicing required when:

a) the appliance is provided with a flue gas sampling point, or it is otherwise practical to gain access to the flow of combustion products in the flue in accordance with Clause **10**; and

b) the appliance is CE-marked or displays a GC number; and

c) the appliance is:

   1) an open-flue or room-sealed boiler, but excluding back boiler units;

   2) an open-flue or room-sealed warm air heater;

   3) an open-flue or room-sealed water heater, including circulators, but excluding back-circulators; or

   4) a room-sealed convector heater or room-sealed fire, but excluding live-fuel effect room-sealed gas fires.

   *NOTE The list of appliances in c) is based on the research and subsequent operational experience referred to in Annex E. There is insufficient evidence to justify extending this list of appliances to include back boiler units, back-circulators and live-fuel effect room-sealed gas fires.*

**11.3.2** The procedure for determining the level of servicing required, and subsequent actions, should be in accordance with Figure 5.

**11.3.3** The essential safety checks (see Figure 5) include:

a) flueing;

b) ventilation;

c) heat input and/or operating pressure, or, where necessary, both;

d) signs of spillage and/or leakage of combustion products;

e) water leaks;

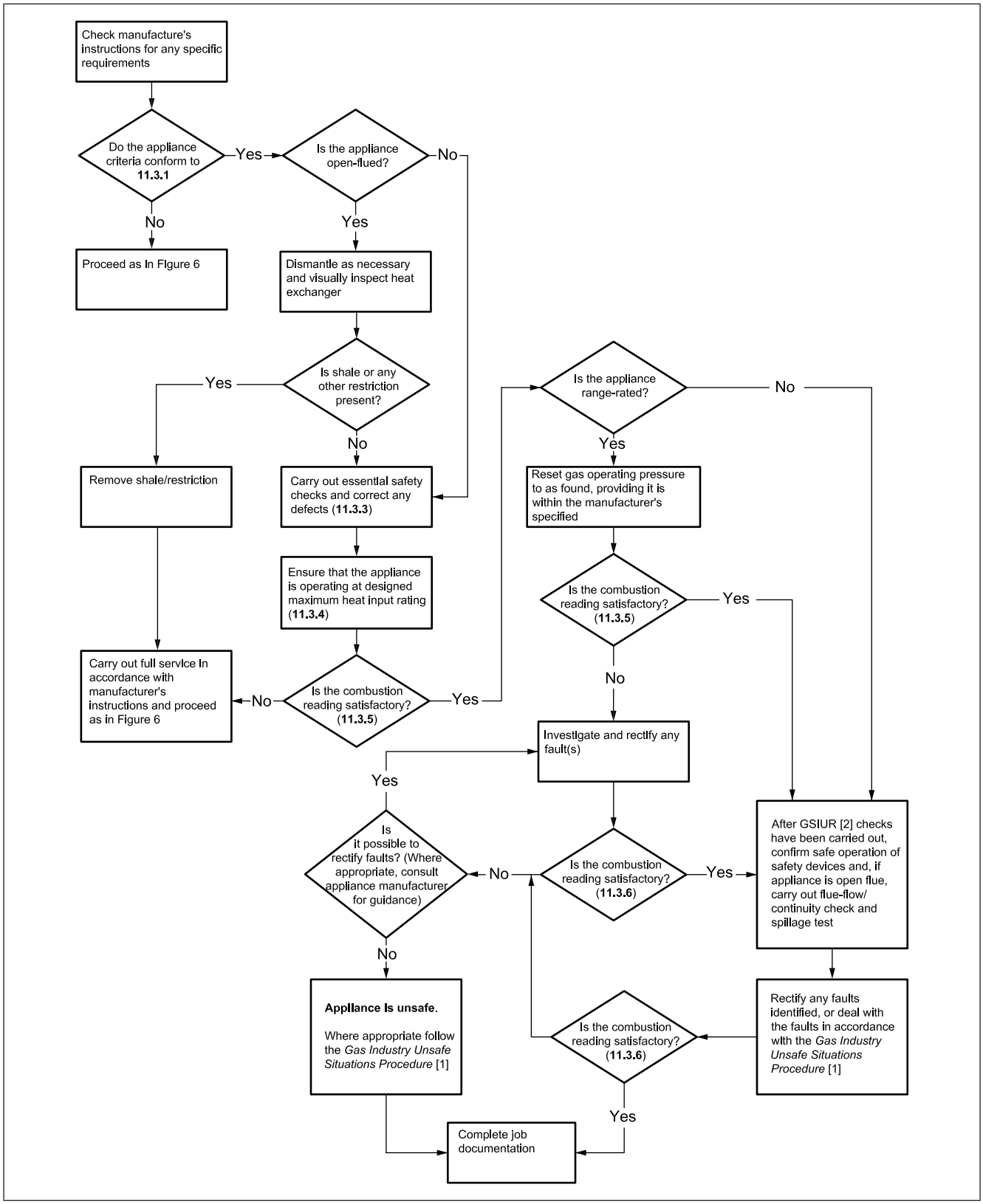
f) heat stress;

g) mechanical deterioration (e.g. corrosion);

h) the integrity of the appliance case seals and joints; and

i) consulting the gas appliance instructions for any special requirements, e.g. checking the operation of safety devices and controls and of condensate removal systems.

Figure 5 **Procedure for use of a gas analyser to determine whether or not the combustion performance is satisfactory, and the subsequent actions to be performed**



**11.3.4** When setting the maximum heat input rating (see Figure 5) it is important that the appliance is not over-rated as this can adversely affect the $CO/CO_2$ ratio.

To set the appliance at its maximum rated input, the method specified in the gas appliance instructions should be followed.

Some modulating gas-fired boilers incorporate a facility that ensures the appliance operates at the designed maximum heat input rating for the period of any combustion gas analysis.

*NOTE The instructions of some boilers fitted with an air gas ratio control valve require the appliance combustion to be checked at full and low rate.*

**11.3.5** For a reading to be satisfactory (see Figure 5) it should conform to either the manufacturer's stated figures or, where no figures are available, a $CO/CO_2$ ratio of less than 0.004 0. Where only a $CO_2$ figure is provided in the gas appliance instructions, a satisfactory reading is one that conforms to the stated $CO_2$ figure and to a $CO/CO_2$ ratio of less than 0.004 0.

**11.3.6** For a reading to be satisfactory (see Figure 5) it should conform to either the figures stated in the gas appliance instructions or, where no figures are available, a $CO/CO_2$ ratio of less than the relevant action level given in Table 3. Where only a $CO_2$ figure is provided in the gas appliance instructions, a satisfactory reading is one that conforms to the stated $CO_2$ figure and to a $CO/CO_2$ ratio of less than the relevant action level given in Table 3.

## 11.4 Confirmation of satisfactory combustion following servicing in accordance with the gas appliance instructions (Figure 6)

**11.4.1** In circumstances where the criteria in **11.3.1** are not met, servicing should be undertaken in accordance with the gas appliance instructions. Following any such servicing, a gas analyser may be used, where appropriate, to check that the combustion of a gas appliance is satisfactory. Where such a gas analyser is used, the procedure in Figure 6 should be adopted.

**11.4.2** When setting the maximum heat input rating (see Figure 6) it is important that the appliance is not over-rated as this can adversely affect the $CO/CO_2$ ratio.

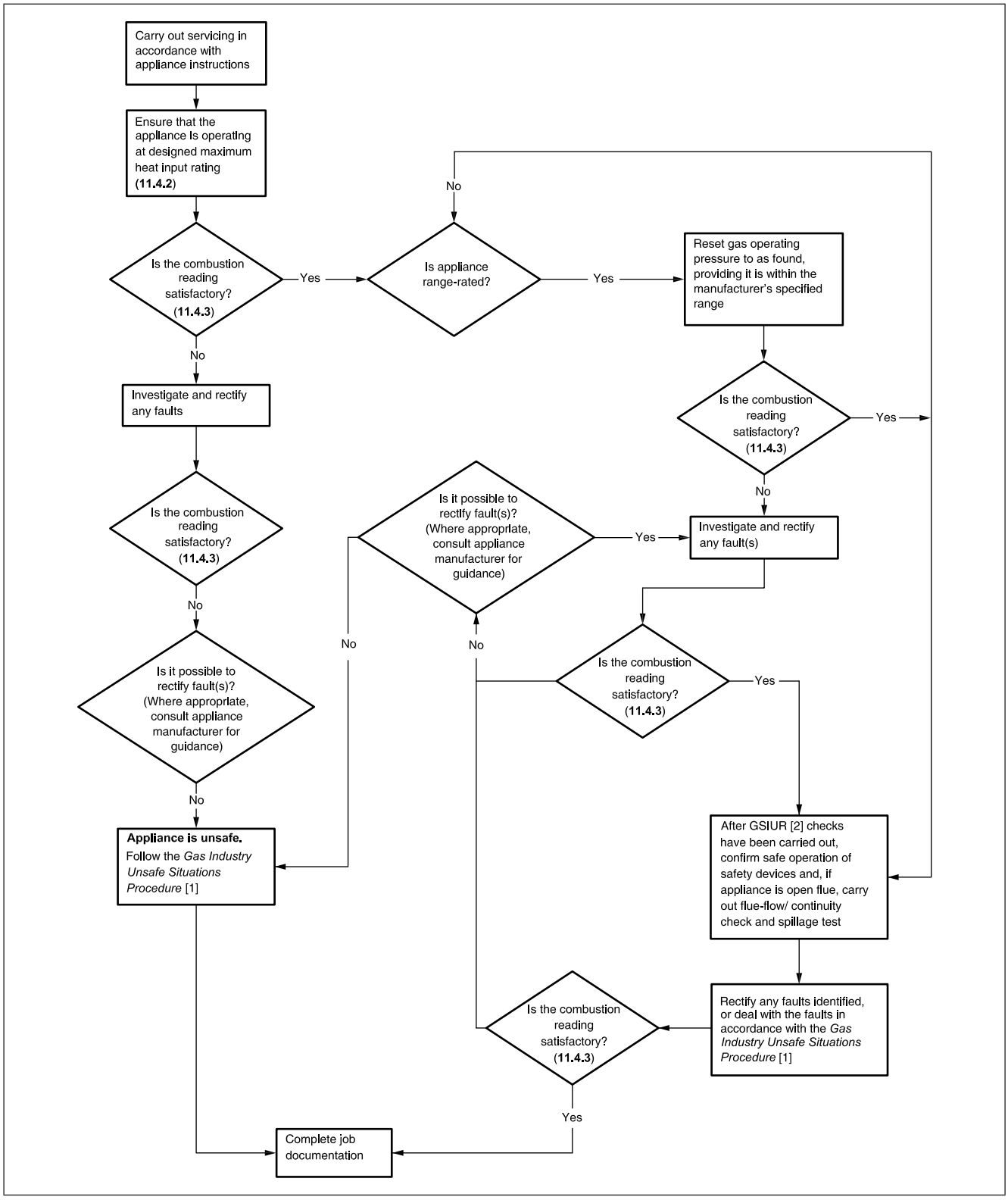
To set the appliance at its maximum rated input, the method specified in the gas appliance instructions should be followed.

Some modulating gas-fired boilers incorporate a facility that ensures the appliance operates at the designed maximum heat input rating for the period of any combustion gas analysis.

*NOTE The instructions of some boilers fitted with an air gas ratio control valve require the appliance combustion to be checked at full and low rate.*

**11.4.3** For a reading to be satisfactory (see Figure 6) it should conform to either the figures stated in the gas appliance instructions or, where no figures are available, a $CO/CO_2$ ratio of less than the relevant action level given in Table 3. Where only a $CO_2$ figure is provided in the gas appliance instructions, a satisfactory reading is one that conforms to the stated $CO_2$ figure and to a $CO/CO_2$ ratio of less than the relevant action level given in Table 3.

Figure 6 **Procedure for the use of a gas analyser as an aid to checking combustion performance subsequent to servicing carried out in accordance with the gas appliance instructions**

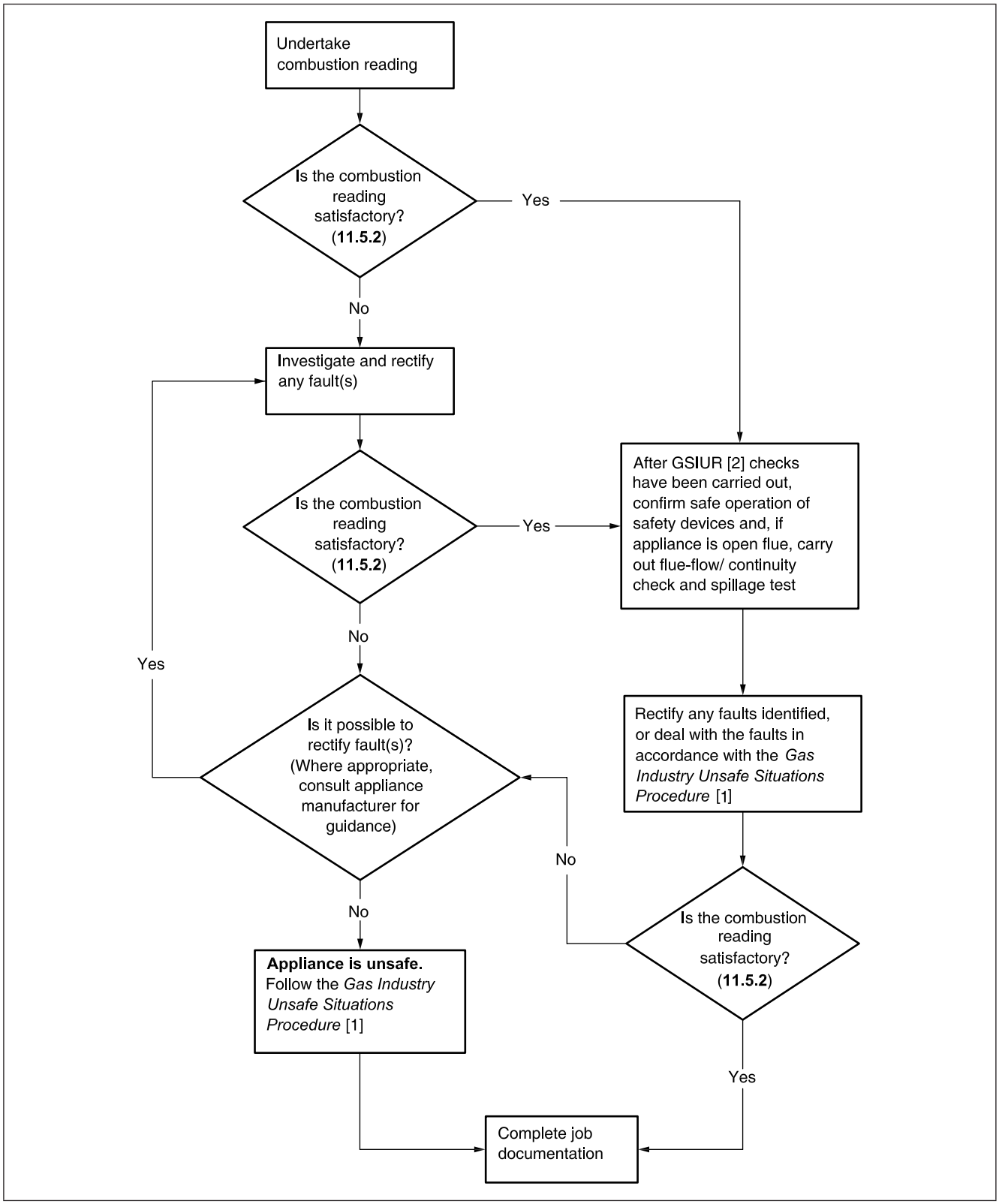



## 11.5 Confirmation of satisfactory combustion following maintenance (Figure 7)

**11.5.1** A gas analyser may be used, where appropriate, to confirm satisfactory combustion following maintenance. Where this is the case the procedure in Figure 7 should be adopted.

**11.5.2** For a reading to be satisfactory (see Figure 7) it should conform to either the figures stated in the gas appliance instructions or, where no figures are available, a $CO/CO_2$ ratio of less than the relevant action level given in Table 3. Where only a $CO_2$ figure is provided in the gas appliance instructions, a satisfactory reading is one that conforms to the stated $CO_2$ figure and to a $CO/CO_2$ ratio of less than the relevant action level given in Table 3.

Figure 7 **Procedure for the use of a gas analyser to confirm satisfactory combustion following maintenance**



*COMMENTARY ON **11.3**, **11.4** AND **11.5***
*The following is a list of considerations to be taken into account when servicing and maintaining gas appliances using gas analysers.*

*For appliances with a cast iron heat exchanger corrosion can, under certain circumstances, take place causing shaling to occur. Debris can also accumulate in other types of heat exchangers. Over time this can result in the heat exchanger becoming restricted or blocked. It is important, therefore, when servicing an open-flue appliance that a visual examination is made on the condition of the heat exchanger and any restriction within the heat exchanger flueways is removed.*

*Experience has shown that for appliances with close-finned, copper-fabricated heat exchangers, the burner flame picture might appear satisfactory but the gas analyser could reveal that combustion is unsatisfactory, even though the heat exchanger appears to be clear. These heat exchangers are prone to restriction by the accumulation of deposits which appear as a white dust on the fins. Small quantities of deposits can cause restriction within the heat exchanger, which in turn can significantly affect the combustion. These deposits can be difficult to remove with conventional brushing and it might be necessary to wash the heat exchanger.*

*With some types of heat exchanger construction, washing might be the only available method for cleaning. Where washing is appropriate this is normally referred to in the gas appliance instructions.*

*Never assume that a final test ratio failure is due to incorrect sampling technique or equipment failure. If necessary the gas appliance manufacturer needs to be consulted for further guidance.*

# 12 Combustion action levels

## 12.1 General

Combustion performance is expressed as the ratio of the concentration of carbon monoxide to carbon dioxide ($CO/CO_2$) in the combustion products.

For many modern high-efficiency appliances the combustion performance ($CO/CO_2$ ratio) action levels are given in the appliance instructions.

For appliances where the combustion performance action levels are not given in the appliance instructions, action levels for individual types of appliances are given in Table 3. The values in the table apply to 2nd and 3rd family gases, except for the values for cabinet heaters, refrigerators and gas lights, which only apply to 3rd family gases.

The values in Table 3 are based on current experience and for some appliance types (both old and new) the relevant British Standard for the appliance might allow higher values, usually not exceeding 0.01 or 0.02 depending on the appliance type.

*NOTE The $CO/CO_2$ ratios measured during testing in the customer's home is often much lower than those shown in Table 3.*

Where specific action levels are given in appliance instructions these should always be used rather than the general values listed in Table 3.

Where action levels are not given in the appliance instructions and higher $CO/CO_2$ ratios than those listed in Table 3 are obtained, or, if an appliance type is not included in Table 3, then the appliance manufacturer should be consulted.

Higher levels than the maximum allowed in the British Standard for the appliance are not acceptable.

### 12.2 $CO/CO_2$ ratios above the action level

In some cases high $CO/CO_2$ ratios might be the result of an appliance and/or its component part(s) experiencing one or more of the following:

a) misuse;

b) lack of maintenance (sometimes by the customer, e.g. excessively soiled cooker grill frets or misplaced coals on fuel effect fires);

c) damage; and

d) ageing.

It is therefore important to examine the appliance thoroughly. Damaged parts should be replaced with new parts that are approved by the appliance manufacturer. Excessively soiled parts should either be cleaned or replaced.

The appliance should be re-tested to confirm that the action taken has rectified the problem.

It should be noted that certain components contain volatile compounds for which it is necessary to "burn off the newness" before reliable measurements can be obtained. Examples include a gas fire ceramic fibre fuel effect, a cooker grill fret, insulation and adhesives. Consequently, if such a component is fitted as a replacement, it is also necessary to burn off the newness before a reliable measurement can be obtained.

It is recommended that when a new component has been fitted, the appliance is operated at full rate and a combustion reading taken after 10 min. If the reading is unacceptable or still rising continue sampling at 20 min intervals until a satisfactory stable level is reached or the level stabilizes at an unacceptable level. For the latter, if the level does not fall within 20 min, then a further inspection of the appliance should be made to establish the cause of the high reading.

### 12.3 Failure to achieve a satisfactory combustion performance

Where it is not possible to achieve a $CO/CO_2$ ratio at or lower than the levels specified in the appliance instructions, or where these are not given, the levels in Table 3, the continued use of the appliance might constitute a danger to persons. In such circumstances, attention is drawn to the requirements of the Gas Safety (Installation and Use) Regulations [2], Regulation 34, and the *Gas Industry Unsafe Situations Procedure* [1].

*NOTE Guidance on Regulation 34 is contained in Health and Safety Commission (HSC) Approved Code of Practice and Guidance, Safety in the installation and use of gas systems and appliances [11].*

A flued appliance that fails to achieve a satisfactory combustion ratio should be regarded as "At Risk" and a flueless appliance should be regarded as being "Immediately Dangerous" as defined in the *Gas Industry Unsafe Situations Procedure* [1].

## 13 Completion and leaving the property

Where an unsafe situation is found every attempt should be made to leave the appliance working safely. When any defect has been noted, which could affect:

a) the effectiveness of the flue;

b) the supply of combustion air;

c) the operating pressure or heat input of the appliance; or

d) the safe functioning of the appliance,

either correct the defect, or make safe in accordance with the *Gas Industry Unsafe Situations Procedure* [1]. If hazardous levels of CO remain in the property that are not attributable to gas appliances, recommend that the property remains evacuated until an appropriate authority, such as the local Environmental Health Department, advises otherwise.

Where the guidance in the relevant clause(s) has been followed in full and no faults are found which could have resulted in the occurrence as reported by the customer, the installation can be reinstated. However, where no fault has been found on this and a previous occasion, reinstate the appliance and recommend to the customer further investigation and long-term monitoring. In both circumstances advise the customer that, whilst no sources of CO have been identified, if the customer continues to feel unwell, he/she ought to consult their doctor and ask if the doctor thinks that it would be appropriate for the customer to have a blood test in order to establish whether they have been exposed to CO.

Recommend regular servicing of all gas appliances where such arrangements are not in place.

Where the customer does not have an electrical CO detector fitted, he/she should be made aware of the potential contribution to safety, for all fuel-burning appliances, that such an alarm can make. However, it should be stressed that such detectors are to be regarded only as a "back-up precaution" and not a substitute for proper installation and maintenance of appliances and flues.

# 14 Reports

In all situations the gas operative should leave a report that provides sufficient detail to enable the customer to understand the nature of the tests carried out, the results, the status of all relevant appliances and any remedial action required. A copy of the report of the results should be made available to the responsible person for the dwelling, e.g. the occupier, the landlord or their agent.

Wherever "work" on a gas appliance has involved the use of a gas analyser, the report should include the "as left" $CO/CO_2$ combustion ratio and/or other readings required by the gas appliance instructions.

It is recommended that a standard reporting format is used to ensure that all necessary information is conveyed to the appropriate persons. An example of an appropriate format of a dwelling investigation report is given in Annex F and an example of an appropriate appliance investigation report is given in Annex G.

If the customer does not authorize the investigation of a suspect appliance, this should be documented.

Where other sources of CO are suspected, the gas operative should ensure that the customer and, where possible, any other persons potentially affected (e.g. neighbours if it is suspected that the source of CO originates from a neighbouring property) are aware of such concerns and have been advised to ensure that appropriate follow-up action is carried out. All such advice should be documented.

Outstanding work or recommendations for additional items such as CO detectors, servicing arrangements and advice on the correct use of appliances should also be documented and left with the customer. Not all customers are in a position to adequately advise all appropriate people, such as other members of the household or a landlord, with regard to important safety information if this has only been conveyed orally.

# Annex A (informative) Gas analyser

Gas analysers that conform to BS EN 50379-3 or BS 7927 extract a sample of combustion products.

They:

a) dry and filter the sample, and measure, calculate and display its characteristics before exhausting it from the gas analyser;

b) are hand-held or portable, with a display and keypad for information and control;

c) are battery and/or mains powered and have an automatic pump;

d) use an external probe to extract combustion products from a sample point for measurement and calculation within the gas analyser;

e) use a filter/water trap to remove particles and water vapour from the combustion products sample;

f) depending on the type of sensor fitted, measure the CO and $O_2$ and calculate the $CO_2$ value, or measure the CO and $CO_2$ and calculate the $O_2$ value in the combustion products sample; and

g) calculate the $CO/CO_2$ ratio of the combustion products sample.

A gas analyser that conforms to BS EN 50379-3 or BS 7927 is identified by a label on the gas analyser.

A gas analyser that conforms to BS EN 50379-3 or BS 7927 is not designed for continuous measurement.

A gas analyser might also measure temperature, nitrogen monoxide (nitric oxide, NO), pressure, excess air and combustion efficiency.

*NOTE 1 Most gas analysers do not measure the absolute levels of CO and $O_2$.*

*NOTE 2 CO detectors conforming to BS 7860 or BS EN 50291, which detect and indicate or alarm if a predetermined CO exposure level is present in the space where they are fitted, are unsuitable for use as gas analysers or ambient air analysers.*

# Annex B (informative) Movement of CO in buildings

## B.1 General

The dispersion and accumulation of CO generated by gas-fired installations operating under fault conditions proceeds in accordance with certain basic principles of physics.

The temperature of the combustion products produced by an appliance is significantly greater than that of room air and this means any discharging into a room tends to be buoyant and rise in the surrounding air. Only on cooling does this buoyancy subside, causing the density of the CO component in particular to become very similar to that of the room air. The tendency for CO to mix in a room also depends upon the extent of any thermal convection present, i.e. the flow of warm air in a heated room which tends to generate an even temperature distribution within.

## B.2 CO build-up from a gas installation operating in a single room

A space heating installation operating under fault conditions, for example a flueless heater with poor combustion or a gas fire with inadequate flueing, tends to cause CO to build up evenly between the floor and ceiling of the room within which the appliance is operating.

Malfunctioning installations involving appliances which are not intended to heat the room in which they operate and which can generate CO from a source position above floor level (for example, the hotplate of a cooker with poor combustion, a sink water heater left on for an excessive period or an open-flue wall-mounted boiler with inadequate flueing) tends to cause the CO concentration to rise more rapidly at and above the height at which CO is produced.

## B.3 Migration of CO in a building

When CO flows into a room as a consequence of a gas installation operating under fault conditions, the greatest and most rapid build-up tends to occur within the room where the CO source exists. CO movement through the building usually follows even when any doors to the appliance room appear closed. This migration to adjacent rooms on the same floor level often proceeds via gaps around the doors or through any open doorways, and results in a build-up within adjacent rooms that reflects the CO concentration distribution in the appliance/source room.

It is important to realize that CO generated in one part of a building might also migrate to other less adjacent parts of the building and this could involve movement between individual properties in the same construction.

The movement of CO between floors can proceed in a number of different ways. CO movement from an appliance room to an upper floor via a stairwell, for example, tends to cause CO to accumulate uniformly between floor and ceiling level in upstairs rooms. Migration of CO to floors at a lower level than the source can happen if thermal conditions outside the appliance room promote mixing, although this process can tend to take place less easily than dispersion of hot buoyant combustion products to an upper floor. Such movement can frequently make the detection of CO particularly difficult in multi-occupancy and multi-storey buildings where CO produced at one location is able to move to another part of the building, for example across roof spaces, through other rooms, along ducting, and via shared flue systems.

Also note that a faulty flue or chimney could allow combustion products to migrate through a building. The rate at which CO moves around and the manner in which it builds up as a result depends on variables such as the nature of any opening into another room (e.g. a hole or a small crack causing CO to flow low down in the room or high up), the temperature of the combustion products at this location (hotter products tend to be more buoyant) and the flow of air within that room (e.g. in heated rooms).

Ducted warm air systems can also provide routes for CO migration. If a warm air installation is defective, it is possible for combustion products to enter the circulated air system and therefore become distributed throughout a property.

The principles of CO movement around a building have been substantiated by independent research work commissioned by HSE in conjunction with Advantica Ltd (formerly BG Technology) and the Building Research Establishment (BRE) [24], [25].

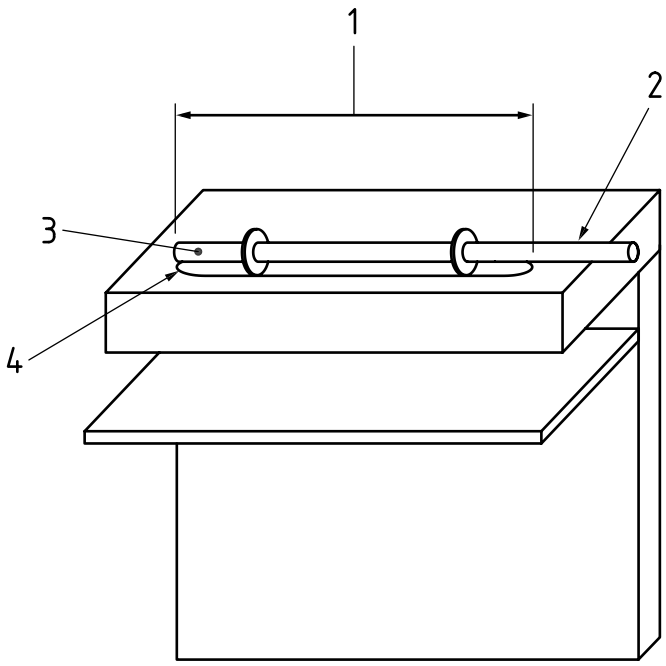
 

**Annex C (normative)**

# Multi-hole sample probes

It is recommended that multi-hole sampling probes shown in Figure C.1 and Figure C.2 should be made from thin walled rigid 6 mm OD metallic tubing.

Figure C.1 **Probe for gas cooker grill**

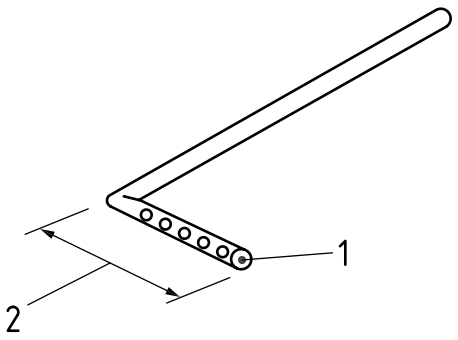



Seven 1.8 mm diameter sampling holes should be spread evenly along the sampling section of the probe.

**Key**

1 Sampling section of 250 mm
2 Sampling probe
3 Sealed end of sampling probe
4 Grill opening

Figure C.2 **Angled probe**




Five 1.8 mm diameter sampling holes should be spread evenly along the sampling section of the probe.

**Key**

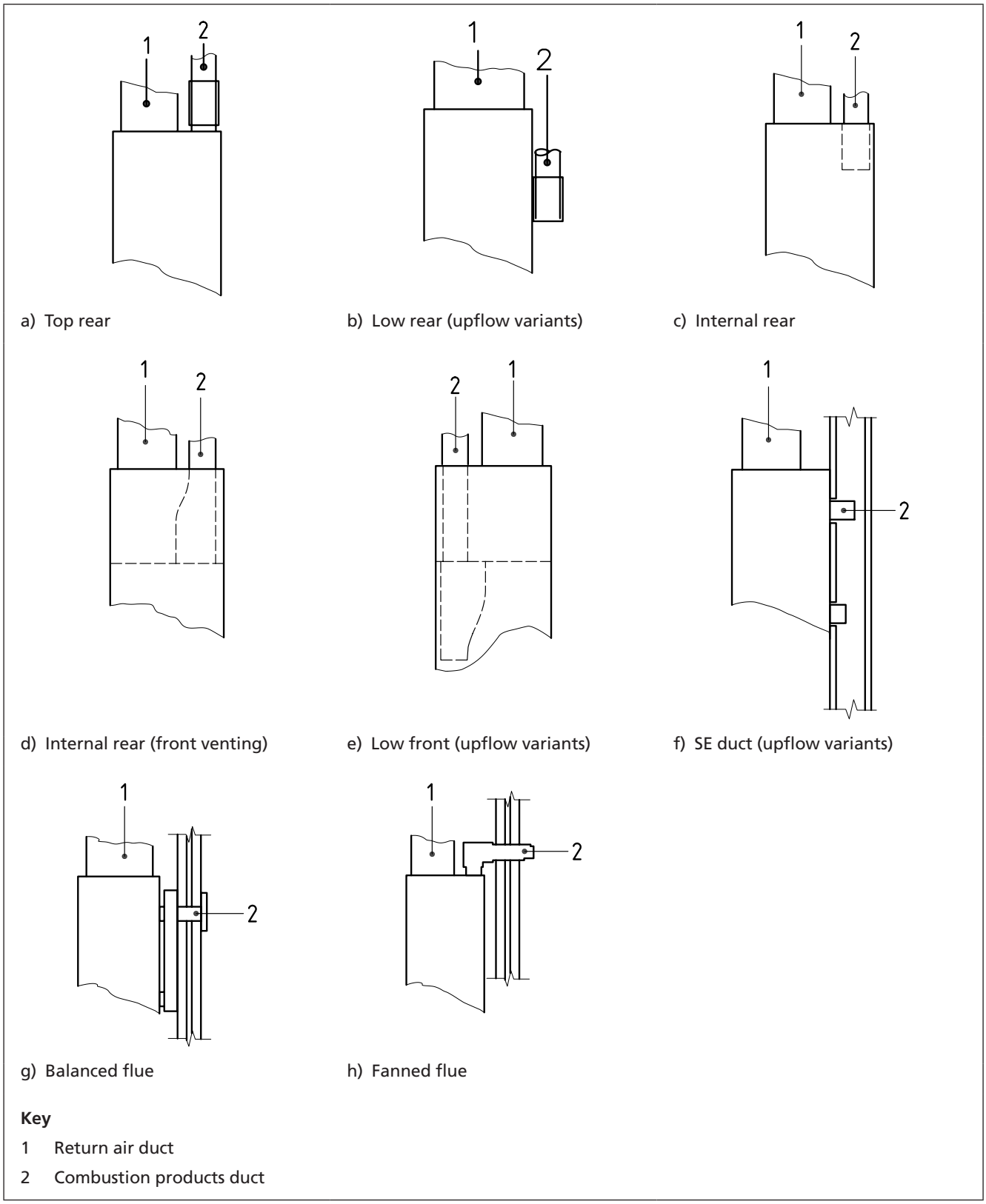
1 Sealed end of sampling probe
2 Sampling section of 125 mm

**Annex D (informative)**

# Flue/draught diverter configurations for warm air heaters

Typical flue/draught diverter configurations for air heaters are shown in Figure D.1.

Figure D.1 **Flue/draught diverter configurations for warm air heaters**




**Key**

1 Return air duct

2 Combustion products duct

**Annex E (informative)**

# Background to the use of a gas analyser in regular servicing

Research by British Gas plc in the 1980s established that a visual observation of an appliance and its flame picture was unreliable in determining the need for servicing and maintenance.

The research established that for some types of British Gas Service listed appliances, following servicing in accordance with the gas appliance instructions, a final combustion performance ratio ($CO/CO_2$) of less than 0.0080 was an indication that the appliance was operating satisfactorily and could be safely relied upon to do so up to the next annual servicing.

Additionally, field trials in the early 1990s established that using an "as found" $CO/CO_2$ ratio of less than 0.0040 for those same types of British Gas Service listed appliances, the conventional servicing activity of a full strip and clean of the combustion circuit components was not required. However, the requirement to check the operation of safety devices remained.

*NOTE An overview of the Research is given in Advantica report R5205, Combustion Performance Safety Action Levels for Domestic Gas Appliances [26].*

# Annex F (informative) Dwelling investigation report

An example format for a dwelling investigation report is provided in Figure F.1.

Figure F.1 **Example format of a dwelling investigation report**

<table>
<tr><td colspan="2">BS 7967 dwelling investigation report</td><td>Job ref. no.:</td></tr>
<tr><td>Job address<br>Name:<br>Address:<br>Postcode:<br>Tel. no.:<br>Report left with:</td><td>Client details if different<br>Name:<br>Address:<br>Postcode:<br>Tel. no.:<br>Is the property rented?</td><td>Registered business details<br>Company:<br>Address:<br>Postcode:<br>Tel. no.:<br>Gas Safe Register reg. no.:<br>Gas operative’s name:<br>Gas Safe Register ID card serial no.:</td></tr>
<tr><td colspan="3">Problem as reported by occupier</td></tr>
<tr><td colspan="3">What is the problem?<br>When does it happen/is there a pattern to the occurrences?<br>Is it happening now?<br>Which gas appliances were on at the time?<br>Were there any other fuel-burning appliances in operation?<br>Who was affected?<br>What were the occupier’s symptoms?<br>Were there any extreme weather conditions at the time?</td></tr>
<tr><td>Observations</td><td colspan="2">Conclusions</td></tr>
<tr><td rowspan="6">Initial CO readings on entering property (ppm):<br>Which appliances were in operation?<br>How many appliances were in operation?<br>No. of appliances examined?<br>Which appliances were checked?<br>Gas tightness test on whole installation: Pass/Fail</td><td colspan="2">Problems were identified and the installation/appliances have been made safe? Yes/No</td></tr>
<tr><td colspan="2">Rectification work completed/required is detailed on the attached sheets? Yes/No</td></tr>
<tr><td colspan="2">The installation is safe to use and no defects were identified? Yes/No</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td>Gas operative’s signature</td><td>Date</td></tr>
<tr><td></td><td></td></tr>
</table>

**Annex G (informative)**

# Gas appliance investigation report

An example format for a gas appliance investigation report is provided in Figure G.1.

Figure G.1 **Example format of a gas appliance investigation report**

| **BS 7967:2015 gas appliance investigation report** | **Job ref. no.:** |
|---|---|
| Field | Response |
| Appliance type | |
| Gas family type | |
| Location | |
| Make | |
| Model | |
| Serial no. | |
| Flue type | Type A/Type B/Type C |
| Visual condition of the flue and termination satisfactory? | Yes/No/Not applicable |
| Is flue to current standard? | Yes/No/Not applicable |
| Flue flow test | Pass/Fail/Not applicable |
| Spillage/leakage test | Pass/Fail/Not applicable |
| Weather conditions during test | |
| Condition of appliance on visual inspection | Good/Poor/Sooty/Other<br>If other, state which: |
| Combustion test readings (**8.3** and Clause **10**):<br>CO (ppm)<br>$CO_2$ (%)<br>$CO/CO_2$ ratio | |
| CO measured in atmosphere (Clauses **6** and **8**):<br>initially (ppm)<br>after appropriate Clause **8** test (ppm) | |
| Ventilation satisfactory | Yes/No/Not applicable |
| Burner operating pressure (mbar) and gas rate | |
| Appliance satisfactory after detailed investigation? | Yes/No |
| List the faults identified | |
| Note of rectification work completed | |
| Rectification work still required | |
| Is the appliance safe to use? | Yes/No |
| If appliance not checked, state why | |

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BS 5546:2010, *Specification for installation of hot water supplies for domestic purposes, using gas-fired appliances of rated input not exceeding 70 kW*

BS 5864, *Installation and maintenance of gas-fired ducted air heaters of rated input not exceeding 70 kW net (2nd and 3rd family gases) – Specification*

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BS 7860, *Specification for carbon monoxide detectors (electrical) for domestic use*[2)]

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