

**Methods for the sampling and  
analysis of**

**Flue gases —**

**Part 1: Methods of sampling**

UDC 662.613.5:543.271

## Co-operating organizations

The Solid Fuel Industry Standards Committee, under whose supervision this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:

|                                                                                                     |                                                                    |
|-----------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|
| Association of Consulting Engineers                                                                 | Gas Council*                                                       |
| British Cast Iron Research Association                                                              | Heating and Ventilating Contractors' Association                   |
| British Coke Research Association*                                                                  | Institute of British Foundrymen                                    |
| British Ironfounders' Association                                                                   | Institute of Fuel*                                                 |
| British Mechanical Engineering Confederation                                                        | Institution of Gas Engineers*                                      |
| British Steel industry*                                                                             | Institution of Heating and Ventilating Engineers                   |
| Chamber of Coal Traders                                                                             | Institution of Mechanical Engineers                                |
| Chemical Industries Association*                                                                    | Low Temperature Coal Distillers' Association of Great Britain Ltd. |
| Coal Utilisation Council                                                                            | National Coal Board*                                               |
| Coke Oven Managers' Association                                                                     | Society of British Gas Industries*                                 |
| Combustion Engineering Association                                                                  | Water-tube Boilermakers' Association*                              |
| Council of Ironfoundry Associations                                                                 | Women's Advisory Council on Solid Fuel                             |
| Department of the Environment*                                                                      |                                                                    |
| Department of Trade and Industry*                                                                   |                                                                    |
| Domestic Solid Fuel Appliances Approval Scheme                                                      |                                                                    |
| Electricity Council, the Central Electricity Generating Board and Area Boards in England and Wales* |                                                                    |

The Government departments and scientific and industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this standard:

|                                      |                                                  |
|--------------------------------------|--------------------------------------------------|
| British Ceramic Research Association | Institution of Electrical Engineers              |
| British Laboratory Ware Association  | Iron and Steel Institute                         |
| Cement Makers' Federation            | Scientific Instrument Manufacturers' Association |
| Institute of Petroleum               | Society of Chemical Industry                     |
| Institute of Water Pollution Control | Society of Glass Technology                      |
| Institution of Chemical Engineers    |                                                  |
| Institution of Civil Engineers       |                                                  |

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## Foreword

In order to Keep abreast of progress in the industries concerned, British Standards are subject to periodical review. Suggestions for improvements will be recorded and in due course brought to the notice of the committees charged with the revision of the standards to which they refer.

A complete list of British Standards, numbering over 5000, fully indexed and with a note of the contents of each, will be found in the British Standards Yearbook, which may be purchased from BSI Sales Department. It may also be consulted in many public libraries and similar institutions.

This standard makes reference to the following British Standards:

BS 893, *Method of testing dust extraction plant and the emission of solids from chimneys of electric power stations.*

BS 1042, *Code for flow measurement.*

BS 1250, *Domestic appliances burning town gas.*

BS 2069, *Gas sampling tubes.*

BS 3048, *Code for the continuous sampling and automatic analysis of flue gases. Indicators and recorders.*

BS 3156, *Methods for the analysis of fuel gases.*

This British Standard was first issued in 1952 as a guide to the selection of suitable procedures for the sampling and analysis of flue gases. For the purpose of this standard, "flue gas" is defined broadly as the gaseous product arising from the combustion of fuel or from the combustion of any carbonaceous matter in materials being processed. The subsequent revision was extended to cover not only flue gases from domestic and industrial fuel-burning installations but also those from various industrial processes. The present edition is virtually unaltered except for the introduction of SI units, where necessary.

The sampling and analysis of a flue gas is most often required for one or more of the following purposes:

- 1) checking and controlling the efficiency of combustion,
- 2) calculating heat balances,
- 3) detecting air or gas inleakage,
- 4) determining compositions and hence calculating volumes of waste gases,
- 5) determining moisture contents,
- 6) assessing the effect of the gas on other parts of the plant, e.g. corrosion or tube blockage,
- 7) determining substances likely to cause pollution of the atmosphere,
- 8) determining toxic gases.

For the control of combustion efficiency, calculation of heat balances and detecting air inleakage, the determination of carbon dioxide, carbon monoxide and oxygen covers most practical requirements. For more precise work sulphur dioxide, hydrogen and methane must be taken into account and a separate method used for low concentrations of carbon monoxide. In assessing the effect of flue gases on other parts of a plant and in guarding against pollution of the atmosphere, determinations of dew-point, sulphur dioxide, sulphur trioxide and nitrogen oxides may be necessary.

The revised standard has been divided into the following parts:

- *Part 1: Methods of sampling;*
- *Part 2: Analysis by the Orsat apparatus;*
- *Part 3: Analysis by the Haldane apparatus;*
- *Part 4: Miscellaneous determinations;*
- *Part 5: Semi-routine analyses.*

The standard deals with the following determinations.

Carbon dioxide

Oxygen

Carbon monoxide

Hydrogen

Methane

Moisture

Dew-point

Sulphur dioxide

Sulphur trioxide

Nitrogen oxides

Total oxides of sulphur

Except in Part 5, no reference has been made to modern procedures for gas analysis by chromatographic, infra-red or other physical methods, some of which form the basis of other British Standards.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

**Compliance with a British Standard does not of itself confer immunity from legal obligations.**

### Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 18, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.



## Section 1. Introduction

### 1.1 Scope

This Part of this British Standard is devoted primarily to the general principles which are to be followed in order to obtain a representative flue gas sample; these principles apply no matter what the industry or the fuel burning appliance may be.

NOTE The titles of the British Standards referred to in this standard are listed on page ii.

### 1.2 General

In this standard an account is given of the various ways in which a sample may be taken and convenient apparatus which can be used for this purpose is described; also, brief reference is made to more specialized sampling equipment. Special hoods may be required for the sampling of the products of combustion from domestic appliances burning gas such as cookers, hotplates, grillers and boiling burners, water heaters, space heaters, refrigerators, and laundering appliances. These hoods and other special apparatus are described in BS 1250 and other relevant specifications.

The purpose for which the analysis of the sample is required demands consideration, since it influences the method and general procedure of sampling. In testing the domestic gas-burning appliances mentioned above, one of the primary requirements is the measurement of the carbon monoxide — carbon dioxide ratio and hence good analyses of the combustion products are required for the percentages of carbon monoxide and carbon dioxide. It is important, therefore, that the compositions of the samples used for determining both the carbon dioxide and the carbon monoxide should be identical. This is ideally obtained by taking both samples in parallel over the same period.

The acceptable deviation from a truly representative sample should also be established beforehand, as this tolerance, as well as the size of the sample required, will influence the procedure and determine the simplicity or otherwise of the apparatus to be employed. Gas-sampling tubes holding from 100 ml to 250 ml are big enough for analysis on the Orsat or Haldane apparatus but other methods of analysis may require larger samples.

Attention is drawn to the fact that excellent sections on sampling gases are to be found in BS 893, BS 3048 and BS 3156, as well as in such publications as “Particulate clouds, dusts, smokes and mists” (H. L. Green and W. R. Lane, Spon, 1957), “Gas sampling and chemical analysis in combustion processes” (G. Tiné, Pergamon Press, 1961) and “The efficient use of fuel” (HMSO, Second Edition, 1958). The following definitions are taken largely from the latter book.

### 1.3 Definitions

For the purposes of this British Standard, the following definitions apply:

#### **snap sample (spot sample)**

a sample taken quickly at some time in a much longer period during which the gas being sampled is flowing

#### **continuous sample**

a sample collected gradually and continuously throughout the period during which the gas to be sampled is flowing

#### **average sample**

a sample which represents as closely as possible the whole of the gas from which it was withdrawn. The average sample should be identical in composition with the gas as a whole, whatever the variations in composition and in rate of flow from time to time and from point to point in the gas to be sampled. An average sample thus approximates to an ideal sample

#### **sampling probe**

a special tube inserted into part of a plant such as a flue for withdrawing the sample or some gas to be sampled. It is that part of the sampling line which extends into the flue or up to the sampling point

#### **sampling line**

the pipe and accessory apparatus through which the gas withdrawn passes from a plant to the sample container and to any apparatus beyond it such as an aspirator or exhaustor

#### **sample container**

the vessel in which the gas sample is collected and later stored and/or transported to the analysis apparatus

**sampling tube**

one form of the sample container (see BS 2069 and Figure 1)

**sample holder**

another form of sample container of greater volume than a sampling tube. Some forms are described in BS 3156

**aspirator or exhauster**

a pump or other device used to draw off the gas through the sampling line to the sample container

**1.4 Types of sample**

This standard is concerned with the following types of sample:

- 1) snap samples taken from a single point;
- 2) continuous samples taken from a single point in the flue over a period of time;
- 3) snap samples taken simultaneously from two or more positions in the flue;
- 4) continuous samples taken from two or more positions in the flue over a period of time.

