Specification for

Gas meters —

Part 7: Mechanical volume correctors

UDC 662.76 – 791:681.122

Co-operating organizations

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

Department of the Environment
Department of Trade and Industry*
Gas Council*
Heating and Ventilating Contractors' Association
Institution of Gas Engineers*
Institution of Heating and Ventilating Engineers
Liquefied Petroleum Gas Industry Technical Association (UK)*
National Federation of Plumbers and Domestic Heating Engineers
Society of British Gas Industries*
Water-tube Boilermakers' Association

The Government department 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 British Standard:

British Non-ferrous Metals Federation
Chief Fire Officers' Association

This British Standard having been approved by the Gas Industry Standards Committee, was published under the authority of the Executive Board on 15 May 1973

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Contents

Foreword

This British Standard is the seventh of a series relating to meters for gaseous fuels for registering the volume of gas passed.

A mechanical volume corrector is an instrument for attachment to a gas meter designed to indicate the volume of gas which has passed through the meter corrected to stated reference conditions It is accurate within certain stated pressure and temperature ranges, and is driven by the meter or by a servomotor controlled by the meter. The addition of a volume corrector to a meter may affect the performance of the meter. The volume corrector has, therefore, to be matched with the meter so that the accuracy of each remains within the limits specified in the appropriate standard.

In operation, conditions of rapid fluctuation of flow, temperature or pressure may affect the performance of the corrector. If such fluctuations are liable to occur, reference should be made to the manufacturer regarding the performance of the corrector in these conditions.

The other parts of BS 4161, "*Gas meters*", already or soon to be published are:

— *Part 1: Meters of plate construction up to 1 000 ft^3/h rating;*

— *Part 2: Meters of plate construction above 1 000 ft^3/h rating;*

— *Part 3: Unit construction meter of 6 m^3/h rating;*

— *Part 4: Plate constructed positive displacement diaphragm meters for a pressure of 350 mbar*[1)] *and up to 170 m^3/h rating;*

— *Part 5: Positive displacement diaphragm meters for ratings above 6 m^3/h and pressures up to 7 bar*[1)] *(in course of preparation);*

— *Part 6: Rotary displacement and turbine meters for pressures up to 100 bar*[1)].

Factors for the conversion of metric into imperial units are given in Appendix A. More comprehensive conversions will be found in BS 350, "*Conversion factors and tables*".

NOTE A meter used for the sale of gas has to comply with the statutory requirements. The addition of a volume corrector to such a meter does not necessarily mean that the system complies with current statutory requirements.

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 and ii, pages 1 to 8, 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.

[1)] 1 mbar = 10^2 N/m^2 = 0.1 kPa; 1 bar = 105 N/m^2 = 100 kPa

1 Scope

1.1 General. This Part of BS 4161 specifies the points in the design, construction and performance of mechanical volume correctors which are of immediate concern to the user.

1.2 New developments. Notwithstanding the requirements specified in this standard any new designs, materials and methods of assembly giving at least equivalent results are acceptable.

NOTE The titles of the British Standards referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this standard the following definitions apply:

2.1
mechanical volume corrector

a device driven from a gas meter which will indicate the volume of gas which has passed through the meter, corrected mechanically from the actual conditions of measurement to any desired standard conditions. The corrected variables may be temperature, pressure, density, relative density, humidity or compressibility or any combination of these. Some of the variables may be incorporated in the corrector as fixed factors

2.2
type A corrector

a mechanical volume corrector in which the temperature and/or pressure of the gas are measured by appropriate sensing elements and their magnitudes then applied to the correcting mechanism by suitable linkages. Fixed factors for humidity and compressibility may be incorporated

2.3
type B corrector

a mechanical volume corrector in which a sample of gas is enclosed in a deformable chamber, or similar element, which is exposed to the gas under line conditions. The deformation of the chamber is a measure of the gas condition and is transferred by suitable linkages to the correcting mechanism. If the enclosed gas is identical with the gas being measured, no corrections will be required for humidity or compressibility, otherwise fixed factors for humidity and compressibility may be included

3 Design and construction

3.1 Materials. A corrector shall be constructed of materials of good quality complying, where applicable, with British Standards. The materials used shall not be adversely affected by conditions arising in that part of the corrector in which they are used.

3.2 Drive. A corrector shall be driven directly or indirectly from the same drive as that which drives the index of the meter. The direction of the drive shall be clearly indicated.

3.3 Sensing elements. Temperature and pressure sensing elements should comply with any relevant British Standards. A sensing element exposed to the gas being metered shall be capable of withstanding a pressure of 1.5 times the maximum of the pressure correction range.

3.4 Sealing. Provision for sealing case joints and indexes shall be made to prevent unauthorized interference.

3.5 Display. A corrector shall indicate the volume of gas passed through the meter corrected to standard reference conditions[2)] or to any other desired standard.

3.6 Windows. An index window shall be of plate glass or material of equivalent performance and useful life. Plate glass windows shall satisfy the impact test given in **B.1.4**. Plastics windows shall satisfy the whole of Appendix B. Windows of other materials shall satisfy equivalent tests.

Windows displaying the interior of the instrument and moulded transparent covers shall also comply with the requirements of Appendix B.

Means shall be provided to prevent or remove condensation from the inner surface of any index window.

3.7 Index. The corrected volume index shall be of the direct reading type. The numerals shall be of uniform height and shall have minimum dimensions of 5 mm high and 2.6 mm wide. The index multiplying factors of the corrected and uncorrected volume indexes may differ if necessary. The drum of the lowest order need not rotate continuously.

3.8 Electrically assisted correctors

3.8.1 If electric power is used in conjunction with the volume corrector, characteristics of the power for which it is designed shall be stated, and variations of ± 10 % on the declared voltage and ± 5 % on the declared frequency shall have no effect on the accuracy of the corrector.

[2)] Standard reference conditions (s.r.c.), as currently defined in the Gas Act 1948, Clause **74**—(1), are 60 °F:, 30 inHg, saturated. It is normally assumed that the condition of the mercury is at 60 °F at latitude 53 °N. The metric based standard reference conditions agreed for use by the British Gas Industry are 15 °, 1013.25 mbar, dry.

3.8.2 If electric power is used in any part of the corrector which is in a hazardous area, all electrical parts shall be intrinsically safe or contained in a flameproof enclosure, the class or group being appropriate to the gases in the hazardous area (see BS 1259 and BS 4683-2). The electrical parts shall be selected and installed as described in CP 1003-1.

3.8.3 If the corrected volume index depends on electric operation, the corrector shall incorporate a second direct reading index, also depending on electric operation, giving the uncorrected volume. The second direct reading index should normally be obscured but it shall be accessible for reading if required.

NOTE 1 Should a power failure occur the difference between the readings of the direct reading indexes on the meter and on the corrector will give the uncorrected volume of gas which has passed through the meter without being registered on the corrected index of the corrector.

NOTE 2 Alternatively to **3.8.3**, an auxiliary power supply may be provided to ensure continued operation of the corrector in case of electric power failure.

4 Performance

4.1 Accuracy. When tested in accordance with Appendix C the error of the corrector, E, defined and calculated as in **C.5** shall be within 1 % for pressure correction and 1 % for temperature correction of the calculated advance. In addition a corrector dealing with both temperature and pressure shall be within 1½ % of the calculated advance for the combined correction while remaining within 1 % for each separately.

4.2 Life. After being tested in accordance with **C.4.5**, the corrector shall still meet the accuracy requirement of **4.1** when subjected to the standard reference test given in **C.4.1**.

4.3 Over pressure. Sensing elements shall not leak when subjected to a pressure of 1.1 times the maximum of the working pressure correction range. The accuracy of the corrector as required in **4.1** shall be maintained after such over pressure on the sensing elements.

4.4 Safety and warning devices. If a corrector incorporates any such devices, e.g. loss of sample warning, each device shall be tested, as appropriate, to verify that it operates in the correct manner and that any malfunction of the device does not affect the operation of the corrector's mechanism or indexes or cause an undetected error to occur in the corrector.

4.5 Ambient temperature. The manufacturer shall specify the ambient temperature range over which the corrector will perform within the requirements of **4.1**.

5 Marking

5.1 Identity badge. The identity badge on a volume corrector shall state the following:

1) The manufacturer's name, serial number and year of manufacturer.

2) The range of pressure correction.

3) The range of temperature correction.

4) Any fixed corrections made for other variables, e.g. relative density, density, humidity, compressibility.

5) The cycle volume of the input drive, e.g. 1 rev = . . . m^3.

6) The maximum rated speed of the input drive.

7) The reference conditions to which corrections are being made and, where relevant, the barometric pressure for which the corrector is calibrated.

8) The characteristics of any electric power required.

NOTE Attention is drawn to the certification facilities offered by BSI: see the inside back cover of this standard.

Appendix A Conversion factors

(Rounded to three significant figures)

Metric to	Imperial
1 m^3	35.3 ft^3
1 N	0.225 lbf
1 mbar (10^2 N/m^2) (0.1 kPa)	0.401 in H_2O
1 bar (10^5 N/m^2) (100 kPa)	14.5 lbf/in^2
15 °C	59.0 °F
5 Celsius degrees	9 Fahrenheit degrees

Appendix B Requirements and tests for plastics index windows (see 3.6)

NOTE **B.1.4** also applies to plate glass windows.

B.1 Requirements

B.1.1 *General.* Both as supplied and after being subjected to the accelerated deterioration tests in **B.2**, samples of window panes or mouldings shall meet the following requirements. The accelerated deterioration tests shall be performed on samples which have not been previously subjected to the flammability test.

B.1.2 *Visual inspection.* The window pane or moulding shall show no crazing or blisters. The portion through which the index is viewed shall be colourless, transparent, have a high polish, and cause no visual distortion of the matter to be viewed when viewed from any direction from the front of the corrector within an angle of 15° from the normal to the window.

B.1.3 *Rigidity.* With the window fitted on the corrector as in operation and at a temperature of 30 ± 2 °C, a 10 mm diameter timber rod applied normal to any external part of the window or moulding with a force of 200 N shall not cause it to touch any moving part of the mechanism.

B.1.4 *Impact.* The window, fitted as in the corrector and at a temperature of – 5 ± 1 °C, shall be undamaged by the impact of a 25 mm diameter solid steel ball dropped three times from a height of 250 mm, striking the centre of the window and falling normal to its plane.

B.1.5 *Flammability.* The material shall satisfy the requirements for very low flammability when tested in accordance with Method 508D, Flammability (alcohol cup test) of BS 2782-5. For this test the specimen shall be a complete window and the centre of the window shall be positioned with its external face downwards on the centre of the wire grid.

B.2 Accelerated deterioration tests

B.2.1 *General.* One sample is subjected to the deterioration tests described in **B.2.2** and another sample to the tests described in **B.2.3**. After these deterioration tests and before being given the flammability test the samples shall still fit the corrector.

B.2.2 ***Effect of ultra-violet light and loss of volatile plasticizer***

B.2.2.1 *Radiation test.* The window shall be exposed for 5 periods of 8 hours' duration to the radiation of a suspended "sun lamp" which has been in use for not less than 50 hours and not more than 400 hours. The light source shall be a combination tungsten filament, mercury-arc enclosed in glass which has a low transmission below 280 nm. The glass envelope shall be conical in shape and silvered internally to form a reflector. The lamp shall be rated at 275 W to 300 W. The window shall be positioned on a white sheet with its outer face towards the lamp, and 400 mm from the bottom and on the axis of the lamp. The surrounding air shall not be confined and shall be free to circulate.

After each exposure except the last, the window shall be immersed completely in distilled water for 16 hours. It shall be cleaned with distilled water and carefully dried with cotton wool after each immersion period.

B.2.2.2 *Loss of volatile plasticizer.* The window shall be heated in air at 100 ± 3 °C for 24 hours. In this test the window shall be reasonably supported so as not to encourage deformation.

B.2.3 *Resistance to chemical substances.* The window shall be constrained as it will be in the corrector and then totally immersed in the following technically pure substances in turn, in the order listed, at 20 ± 3 °C:

1) sodium carbonate (20 % concentration by mass) for two hours,

2) paint thinners (50 % aromatic and 50 % aliphatic hydrocarbons e.g. 50 % o-xylene and 50 % n-heptane) for one hour.

The window shall be cleaned with distilled water and carefully dried with cotton wool after each immersion.

Appendix C Testing of mechanical volume correctors

C.1 Introduction

Before tests are carried out, the corrector shall be installed and adjusted in accordance with the manufacturer's instructions (see **C.3**). A standard reference test (see **C.4.1**) is then performed, and again between each of the other tests and at the end of the last test, to determine whether any test has affected the accuracy of the corrector. The other tests comprise:

1) tests with the corrector at an ambient temperature of 15 °C and at the ambient temperature limits declared by the manufacturer under **4.5** (or other desired temperature) to prove the accuracy of the corrector when operating (see **C.4.2**);

2) a drift test to prove that the performance of the sensing elements does not vary with time (see **C.4.3**);

3) an attitude test to see whether the corrector is affected by small change of level (see **C.4.4**);

4) a life test at overspeed conditions to give an indication of the interval within which recalibration of the corrector should not be necessary (see **C.4.5**);

5) an overpressure test to ensure that such a condition does not damage the corrector and to ascertain the effect of over pressurization on calibration (see **4.3**);

6) a check on any safety and warning devices on the corrector (see **4.4**).

The method of calculating the error of the corrector, E, and the effect of barometric pressure changes on calibration, which must be considered when testing Type A correctors, are given at **C.5** and **C.6**.

C.2 Testing facilities

The following test equipment and facilities are required:

1) A room or cabinet to contain the corrector in which the ambient temperature can be controlled and maintained to within ± 2 °C.

2) Equipment to subject the pressure sensing element of the corrector to any desired gauge pressure and maintain it at that pressure with 95 % confidence limits at ± 0.1 %.

3) Equipment to subject the temperature sensing element of the corrector to any desired temperature and maintain it at that temperature with 95 % confidence limits at ±0.1 % of the absolute temperature.

4) Equipment to drive the corrector input shaft at any desired speed, to maintain it at that speed and to indicate or record the number of revolutions all with 95 % confidence limits at ± 0.1 %.

5) For some testing, a recording barometer working to a time base.

C.3 Initial adjustment and calibration.

Before testing, the corrector shall be installed and adjusted in accordance with the manufacturer's instructions. This calibration normally includes the following requirements:

1) That the pressure system be calibrated at not less than five different pressures. These normally include the minimum, mid-scale and maximum points of the corrector's pressure range.

2) That the temperature system be calibrated at a minimum of three different temperatures. These normally include either 15 °C or the mid-scale point of the corrector's temperature range.

C.4 Tests

C.4.1 *Standard reference test.* This test is performed before and after each of the tests listed at **C.4.2** to **C.4.5** and in **4.3** and **4.4**, to determine whether any test has affected the accuracy of the corrector.

C.4.1.1 *Procedure.* Maintain the corrector's pressure sensing element at the pressure corresponding to that indicated at the point three quarters the way up the corrector's pressure range scale.

Maintain the corrector's temperature sensing element at 15 °C.

Record the reading of the corrected and uncorrected indexes (and any other indexes on the corrector).

Drive the corrector's input shaft at its maximum rated speed until the corrected index has advanced approximately 1 000 counts (i.e. 100 revolutions of the drum of the lowest order). Record the readings of all the indexes and the number of revolutions of the input drive shaft.

NOTE It is essential that the corrector completes exactly a full number of complete cycles of its mechanism.

Calculate the error of the corrector, *E* (see **C.5**).

C.4.2 *Ambient temperature tests.* These tests are to verify the accuracy of the corrector over its full pressure and temperature ranges.

C.4.2.1 *Procedure.* Place the corrector in the room or cabinet with a controlled ambient temperature of 15 ± 2 °C.

For each of sub-tests 1 to 13 shown in Table 1, drive the corrector's input shaft at its maximum rated speed during an advance of approximately 1 000 counts on the corrected index, with the corrector's pressure and temperature sensing elements maintained as given in Table 1.

As in **C.4.1.1** note the necessary readings and calculate the error of the corrector, *E*, in each sub-test.

Repeat sub-test 7 at both the upper and lower limits of the ambient temperature range declared under **4.5** or at other desired temperatures.

Table 1 — Ambient temperature sub-tests (see **C.4.2**)

Element temperature of corrector's temperature range	Element pressure of corrector's pressure range				
	Minimum	25 %	Mid-scale	75 %	90 % to 100 %
Minimum	Sub-test 1		Sub-test 2		Sub-test 3
Intermediate point			Sub-test 4		
Mid-scale	Sub-test 5	Sub-test 6	Sub-test 7	Sub-test 8	Sub-test 9
Intermediate point			Sub-test 10		
Maximum	Sub-test 11		Sub-test 12		Sub-test 13

C.4.3 *Drift test.* This test is to verify that the performance of the corrector's sensing elements remains within the specified limits and shows no tendency to drift outside these limits.

C.4.3.1 *Procedure.* Maintain the pressure sensing element at a pressure corresponding to the mid-scale point of the corrector's pressure range and the temperature sensing element at 15 °C for at least 150 hours. During this time drive the corrector's input drive shaft at its maximum rated speed, and record the corrected index reading at intervals of approximately 1 000 counts difference.

Calculate the error of the corrector, *E*, at each of these intervals. Check that these errors show no sign of deviation or drifting outside the permissible limits of error.

C.4.4 *Attitude test.* This test is to verify that the performance of the corrector remains within the specified limits when the corrector is imperfectly levelled.

C.4.4.1 *Procedure for a corrector which the manufacturer's instructions state has to be installed level.* Set up the corrector inclined at 1° to its normal position in a direction, as judged by inspection, most likely to affect its accuracy. Maintain the pressure sensing element at a pressure corresponding to the mid-scale point of the pressure range and the temperature sensing element at 15 °C. Drive the corrector's input drive shaft at its maximum rate for at least 1 000 counts advance on the corrected index. Calculate the error of the corrector, *E*.

Repeat this test with the corrector inclined at 1° in a direction 90° to the original inclination.

C.4.4.2 *Procedure for a corrector which need not be installed level.* Carry out the procedure given in **C.4.4.1** but with the corrector inclined at 5° instead of at 1°.

C.4.5 *Accelerated life test.* This test is designed to show whether the corrector, in normal operation, will maintain its accuracy for a period of six months without maintenance. The corrector shall satisfy the standard reference test at the end of this life test.

C.4.5.1 *Procedure.* Maintain the pressure sensing element at a pressure not less than the mid-scale pressure of the pressure range and drive the input drive shaft at 150 % of its maximum rating for 100 days.

NOTE The temperature of the temperature sensing element need not be controlled in this test.

C.5 Calculation of accuracy of registration

C.5.1 *Error of the corrector.* The percentage error of the corrector in the tests at **C.4** is determined by first calculating the percentage difference between the actual advance of the corrector index (corrected as necessary for barometric pressure deviation, see **C.6**) and the calculated advance for the number of revolutions of the input shaft which have been used. This figure must then be numerically increased by the arithmetic addition of the uncertainty in it which arises from the percentage uncertainties in the calculation of these two quantities.

The percentage difference, *D*, is given by

$$D = \frac{A - B}{B} \times 100$$

where A = the corrected index advance (see **C.6**)

B = the calculated index advance (see **C.5.2**)

The uncertainty, *y*, (at the 95 % confidence level) in the calculation of *D* is given by

$$y = \frac{A}{B}\sqrt{(x_i^2 + x_n^2 + x_g^2 + x_p^2 + x_T^2 + x_K^2)}$$

where the symbol *x*, with a subscript which denotes the quantity, is the percentage uncertainty (at the 95 % confidence level) in the estimation of that quantity, i.e.

x_i = % uncertainty associated with the corrected index advance

x_n = % uncertainty associated with the number of input shaft revolutions

x_g = % uncertainty associated with the volume corresponding to a revolution of the input shaft

x_p = % uncertainty associated with the absolute pressure measurement

x_T = % uncertainty associated with the absolute temperature measurement

x_K = % uncertainty associated with the coefficient of compressibility

The percentage error of the corrector, *E*, is then given by

$E = D \pm y$

where the positive or negative sign is used according to whether *D* is positive or negative.

A negative value for *E* indicates that the corrector is reading slow, and a positive answer that the corrector is reading fast.

Guidance on accuracy of measurements can be found in Section 4 of BS 1042-1.

C.5.2 *Calculated index advance*

C.5.2.1 For an ideal gas, the following equation applies:

$PV = RT$

where P = absolute pressure

V = molar volume

R = universal gas constant

T = absolute temperature

If the subscript "g" is used to indicate the values of *P, V,* and *T* at gas line conditions and subscript "o" the values of *P, V,* and *T* at the reference conditions, then at line conditions:

$P_g V_g = RT_g$

and at reference conditions:

$P_o V_o = RT_o$

Therefore, the relationship between the volume at reference conditions, V_o, and the volume at line conditions, V_g, is given by:

$$V_o = V_g \frac{P_g T_o}{P_o T_g}$$

In the case of a volume corrector, P_o and T_o are marked on the badge and P_g and T_g can be obtained by using independent pressure gauges and thermometers. The value of V_g can be obtained by multiplying the number of revolutions of the input shaft by the value of one revolution of the input shaft.

C.5.2.2 For a real (non-ideal) gas the equation becomes:

$$PV = ZRT$$

where Z is the compressibility factor.

This equation becomes at line conditions:

$$P_g V_g = Z_g R T_g$$

and at reference conditions:

$$P_o V_o = Z_o R T_o$$

The relationship between the volume at reference conditions, V_o, to the volume at line dimensions, V_g, is then given by,

$$V_o = V_g \frac{P_g}{P_o} \frac{T_o}{T_g} \frac{Z_o}{Z_g} \qquad (1)$$

or

$$V_o = V_g \frac{P_g}{P_o} \frac{T_o}{T_g} \frac{1}{K_g} \qquad (2)$$

where $K_g = Z_g/Z_o$ and is known as the coefficient of compressibility.

The value of K_g can only be used when the correction of volume is to the standard conditions corresponding to Z_o.

NOTE 1 The values of Z depend on the type of gas being metered and its temperature and pressure. The values of Z for which the corrector is calibrated and the source of the data should be obtained from the manufacturer.

NOTE 2 For Type A correctors, see **C.6** regarding the value of P_g to be used in equations (1) or (2) to avoid errors in computing the "calculated advance" of the corrected index on a corrector.

NOTE 3 The validity of the above formulae may be affected by the water content of the gas and attention should be paid to this point if necessary.

C.6 Effect of barometric pressure changes on Type A correctors

The mechanism of a Type A corrector incorporates a Bourdon tube as a pressure sensor. This Bourdon tube is in fact a differential pressure detector measuring the difference, P_m, between gas line pressure, P_g, and atmospheric or barometric pressure, P_a, i.e.

$$P_m = P_g - P_a$$

or $P_g = P_m + P_a$

A Type A corrector may require setting to a mean barometric pressure, in which case it is necessary to decide and set this pressure on the corrector's mechanism before starting calibration and putting the corrector into operation.

In any one situation the barometric pressure will vary from time to time, but over a long period of time will average out to a mean barometric pressure, P_{av}. Over a short period of time when P_a does not equal P_{av}, the corrector's registration will be in error to the extent of

$$\frac{P_{av} - P_a}{P_m + P_a} \times 100\%$$

It is important therefore, before putting the corrector into operation, to determine P_{av} for the situation in which the corrector is to operate, and to conduct the calibration with the corrector at an ambient barometric pressure of P_{av} or to make an allowance for any difference from this in the calibration calculations.

In testing a Type A corrector for accuracy of registration, the effect of variation of the barometric pressure from P_{av} has to be taken into consideration. Over the period of the test either P_m or P_g has to be held constant. Independent of whether P_m or P_g is held constant, the effective absolute pressure to use in equations (1) or (2) is:

$$| (P_g - P_a) + P_{av} |$$

or, expressed in another way,

$$| P_m + P_{av} |$$

However, in testing Type A correctors which incorporate automatic barometric correction, it is the absolute line pressure, P_g, which is used in equations (1) or (2).

Publications referred to

This standard makes reference to the following British Standards and special publication:

BS 1042, *Code for flow measurement*.

BS 1042-1, *Orifice plates, nozzles and venturi tubes*.

BS 1259, *Intrinsically safe electrical apparatus and circuits for use in explosive atmospheres*.

BS 2782, *Methods for testing plastics*.

BS 2782-5, *Miscellaneous methods*.

BS 4683, *Electrical apparatus for explosive atmospheres*.

BS 4683-2, *The construction and testing of flame-proof enclosures of electrical apparatus*.

CP 1003, *Electrical apparatus and associated equipment for use in explosive atmospheres of gas or vapour other than mining applications*.

CP 1003-1, *Choice, installation and maintenance of flame-proof and intrinsically-safe equipment*.

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