Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

“जानने का अधिकार, जीने का अधिकार”
Mazdoor Kisan Shakti Sangathan
“The Right to Information, The Right to Live”

“पुराने को छोड़ नये के तरफ”
Jawaharlal Nehru
“Step Out From the Old to the New”

Indian Standard

ELECTRICAL APPARATUS FOR USE IN THE PRESENCE OF COMBUSTIBLE DUST

PART 2 TEST METHODS

Section 1 Methods for Determining the Minimum Ignition Temperatures

ICS 29.260.20
NATIONAL FOREWORD

This Indian Standard (Part 2/Sec 1) which is identical with IEC 61241-2-1 : 1994 'Electrical apparatus for use in the presence of combustible dust - Part 2: Test methods - Section 1: Methods for determining the minimum ignition temperatures of dust' issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Electrical Apparatus for Explosive Atmospheres Sectional Committee and approval of the Electrotechnical Division Council.

This standard supersedes IS 12315 (Part 2) : 1988 'Methods of determining the minimum ignition temperature of dusts: Part 2 Dust cloud in a furnace at a constant temperature'.

The text of IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker in the International Standard while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to the following International Standard for which Indian Standards also exist. The corresponding Indian Standards, which are to be substituted in its place are listed below along with their degree of equivalence for the editions indicated:

<table>
<thead>
<tr>
<th>International Standard</th>
<th>Corresponding Indian Standard</th>
<th>Degree of Equivalence</th>
</tr>
</thead>
</table>

The technical committee has reviewed the provisions of the following International Standard referred in this adopted standard and has decided that it is acceptable for use in conjunction with this standard:

<table>
<thead>
<tr>
<th>International Standard</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISO 4225 : 1980</td>
<td>Air quality — General aspects — Vocabulary</td>
</tr>
</tbody>
</table>

Only the English language text has been retained while adopting it as an Indian Standard, and as such the page numbers given here are not the same as in the IEC Standard.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (revised)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.
Indian Standard

ELECTRICAL APPARATUS FOR USE IN THE PRESENCE OF COMBUSTIBLE DUST

PART 2 TEST METHODS

Section 1 Methods for Determining the Minimum Ignition Temperatures

1 Scope

This section of IEC 1241-2 specifies two test methods for determining the minimum ignition temperatures of dust.

The methods are not suitable for use with substances having explosive properties.

Method A (clause 4) is applicable to the determination of the minimum temperature of a prescribed hot surface which will result in the decomposition and/or ignition of a layer of dust of a specified thickness deposited on it. The method is particularly relevant to industrial equipment with which dust is present on hot surfaces in thin layers exposed to the atmosphere.

Method B (clause 5) is applicable to the determination of the minimum temperature of a prescribed hot surface which will result in the ignition of a cloud of a given sample of dust or other particulate solid. The test is intended to be carried out as a complementary test after determining the minimum ignition temperature of a dust layer by method A of this standard.

NOTES concerning method B

1 Because the method of operation of the furnace gives short residence times for dust particles within it, this method of test is applicable to industrial equipment where dust is present as a cloud for a short time. This method of test is of small scale and the results are not necessarily representative of all industrial conditions.

2 The method is not applicable to dusts which may, over a longer period of time than provided for in the test method, produce from deposits gases generated during pyrolysis or smouldering.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this section of IEC 1241-2. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this section of IEC 1241-2 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 565: 1990. Test sieves – Metal wire cloth, perforated metal plate and electroformed sheet – Nominal sizes of opening

3 Definitions

For the purpose of this section of IEC 1241-2, the following definitions apply:

3.1 dust: Small solid particles in the atmosphere which settle out under their own weight, but which may remain suspended in air for some time (includes dust and grit as defined in ISO 4225).

3.2 Ignition of a dust layer: Ignition is considered to have occurred if glowing or flaming is initiated in the material, or a temperature of 450 °C or more, or a temperature rise of 250 K or more above the temperature of the prescribed hot surface, is measured in the test.

3.3 minimum Ignition temperature of a dust layer: Lowest temperature of a hot surface at which ignition occurs in a dust layer of specified thickness on this hot surface.

NOTES
1 Because of the wide range of processes in industry, the ignition of dust layers may be dependent upon local conditions. This method of test is not necessarily representative of all industrial conditions, where account may need to be taken of such factors as the presence of thick layers of dust and of the distribution of temperature in the environment.
2 When carrying out this test, it is essential that all necessary precautions be taken to safeguard the health of personnel, for example, against the risk of fire, explosion, inhalation of smoke and any toxic products of combustion.

3.4 Ignition of a dust cloud: Initiation of an explosion by the transfer of energy to a dust cloud in air.

3.5 Ignition temperature of a dust cloud: Lowest temperature of the hot inner wall of a furnace at which ignition occurs in a dust cloud in air contained therein.

NOTE – When carrying out this test, it is essential that all necessary precautions be taken to safeguard the health of personnel, for example, against the risk of fire, explosion, inhalation of smoke and any toxic products of combustion.

4 Method A: Dust layer on a heated surface at a constant temperature

4.1 Preparation of dust sample

The sample shall be prepared so as to be homogeneous and representative of the dust received for consideration.

The dust sample to be tested shall, in general, be able to pass through a woven metal wire cloth or a square hole perforated plate test sieve with a nominal size of aperture of 200 μm (for supplementary sizes, see ISO 565). If it is necessary to test a coarser dust, passing a test sieve with a nominal size of aperture up to 500 μm, the fact shall be stated in the test report.
Any apparent changes noted in the properties of the dust during preparation of the sample, for example, by sieving or owing to temperature or humidity conditions, shall be stated in the test report.

4.2 Test apparatus

The apparatus is shown schematically in figure A.1. Essential details and performance requirements are given in the following subclauses. Methods of construction to enable these requirements to be met are described in annex A.

4.2.1 Heated surface

The heated surface shall consist of a circular metal plate and shall provide a working area of at least 200 mm in diameter and be not less than 20 mm in thickness. The plate shall be heated electrically and its temperature shall be controlled by a device for which the sensing element is a thermocouple mounted in the plate near the centre and with its junction within 1 mm ± 0.5 mm of the upper surface and in good thermal contact with the plate.

A similar thermocouple shall be mounted near the control thermocouple in a similar manner, and shall be connected to a temperature recorder to record the temperature of the surface during a test. The heated surface and its control device shall satisfy the following performance requirements:

a) the heated surface shall be capable of attaining a maximum temperature of 400 °C without a dust layer in position;
b) the temperature of the heated surface shall be constant to within ±5 K throughout the period of a test;
c) when the heated surface has reached a steady state, the temperature across the surface shall be uniform to within ±5 K when measured across two diameters at right angles, by the procedure described in annex B. This requirement shall be satisfied at nominal surface temperatures of 200 °C and 350 °C;
d) the temperature control shall be such that the recorded surface temperature does not change by more than ±5 K during the placing of the dust layer, and it shall be restored to within ±2 K of the previous value within 5 min of placing the dust layer;
e) temperature control and measurement devices shall be calibrated and shall have limits of inaccuracy of ±3 K.

4.2.2 Dust layer thermocouple

A fine thermocouple (0.20 mm to 0.25 mm diameter) of chromel-alumel or other suitable material shall be stretched across the heated surface, and parallel to it, at a height of between 2 mm and 3 mm from it with the junction over the centre of the plate. This thermocouple shall be connected to a temperature recorder in order to determine the behaviour of the dust layer during the test.

4.2.3 Temperature measurements

Temperature measurements using thermocouples shall be made either relative to a fixed reference junction or with automatic cold junction compensation. In either case, calibration shall satisfy the requirements of 4.2.1 e).
4.2.4 Ambient temperature measurements

The ambient temperature shall be measured by a thermometer placed not more than 1 m from the heated surface, but shielded from heat convection and radiation from the surface. The ambient temperature shall be within the range 15 °C to 35 °C.

4.2.5 Dust layers

Dust layers shall be prepared by filling the cavity formed by placing a metal ring of appropriate height on the heated surface and levelling the layer to the top of the ring. The ring shall have an internal diameter of nominally 100 mm and shall have slots at opposite ends of a diameter to clear the test thermocouple (figure A.2). The ring shall be left in place during a test.

A given dust shall be tested in a layer of 5.0 mm ± 0.1 mm depth. For predictive purposes (see 4.6) a second depth (such as 12.5 mm ± 0.1 mm or 15.0 mm ± 1 mm) is useful. Rings of appropriate depths will be required.

4.2.6 Formation of dust layer

The dust layer shall be formed without compressing it unduly. That is to say, the dust shall be put into the ring with a spatula and distributed mainly with sideways movement of the spatula until the ring is slightly overfilled. The layer shall then be levelled by drawing a straight edge across the top of the ring. Any excess should be swept away.

For each type of dust, a layer shall be formed in the above manner on a sheet of paper whose weight is known and weighed. The density shall be calculated from the mass of the dust and the filled volume of the ring, and shall be reported.

4.3 Procedure

4.3.1 General

Ignition in particulate or porous solids exposed to elevated temperatures is generally preceded by a more or less protracted period of self-heating (usually due to atmospheric oxidation). Depending on the temperature of exposure, self-heating may result in no more than a transient, though sometimes substantial, rise in temperature within the solid which does not lead to propagation of combustion. Further, the "induction period" for ignition, at temperatures near to the minimum required for ignition is usually many times greater than for ignition in dust clouds or in gases and vapours (minutes or hours rather than seconds). For both reasons the recognition of the minimum ignition temperature of dust layers is less straightforward than for dust clouds or for gases and vapours. It is necessary especially to be certain that failure to ignite at a given temperature is not merely because a test was terminated prematurely.
The occurrence of ignition in a layer of dust on a surface at a given temperature depends critically on the balance between the rate of heat generation ("self-heating") in the layer and the rate of heat loss to the surroundings. The temperature at which ignition of a given material occurs depends, therefore, on the thickness of the layer. Values determined for two or more thicknesses of a given dust may be used for predictive purposes (see 4.6).

Following the recommended procedure, ignition shall be considered to have occurred if:

a) visible glowing or flaming is observed (figure 3a), or
b) a temperature of 450 °C, is measured or
c) a temperature rise of 250 K above the temperature of the heated plate (figure 3c), is measured.

With regard to items b and c above, ignition shall not be considered to have occurred if it can be shown that the reaction does not propagate to glowing or flaming. The temperature shall be measured by thermocouple (see 4.2.2) It will usually be found that, provided the temperature of the heated surface is high enough, the temperature in the layer will slowly increase to a maximum value which may be in excess of the temperature of the heated surface and then slowly fall to a steady value below the temperature of the heated surface (figure 3b). This behaviour is evidence of self-heating in the dust layer and it may often be accompanied by a discoloration of the dust but without active and visible combustion of the layer. If the temperature of the heated surface is slightly higher, the temperature measured in the dust layer will continue to rise instead of passing through a maximum. Some materials exhibit more than one stage of self-heating, and it may sometimes be necessary to prolong the test in order to fully explore this possibility. With organic dust, combustion will usually take the form of charring followed by the appearance of smouldering with glowing which will progress through the layer and leave a residue of ash. With dust layers composed of certain divided metals, ignition may be characterized by the relatively sudden appearance of highly incandescent smouldering combustion progressing rapidly through the layer.

In the determination of the minimum ignition temperature for a layer of given thickness, repeated trials are carried out, using a fresh layer of dust each time and with up-and-down adjustments to the temperature of the heated surface until a temperature is found which is high enough to cause ignition in the layer but which is no more than 10 K higher than a temperature which fails to cause ignition. The highest temperature at which ignition fails to occur shall be confirmed by continuing the test long enough to establish that any self-heating is decreasing in rate; that is, the temperature at the point of measurement in the layer is decreasing to a steady value lower than the temperature of the heated surface.

4.3.2 Method

The apparatus shall be set up in a position free from draughts, and preferably under a hood capable of extracting smoke and fumes.
The temperature of the heated surface shall be adjusted to the desired value and shall be allowed to become steady within the prescribed limits of 4.2.1 b). A metal ring of the required height shall be placed centrally on the heated surface and this ring shall be filled with the dust to be tested and levelled off within a period of 2 min. The recorder for the dust layer thermocouple shall then be started.

The test shall be continued until it is ascertained either that the layer has ignited, either visually or by the thermocouple recording, or has self-heated without igniting and is subsequently cooling down.

If, after a period of 30 min, no self-heating is apparent the test should be terminated and repeated at a higher temperature. If ignition or self-heating occurs the test shall be repeated at a lower temperature, if necessary, prolonging the test beyond 30 min. Testing is continued until a temperature is found which is high enough to cause ignition or self-heating in the layer, but which is no more than 10 K higher than a temperature which fails to cause ignition or self-heating.

4.3.3 Results

Tests shall be repeated with fresh layers of dust until a minimum ignition temperature has been determined. This shall be the lowest temperature, rounded down to the nearest integral multiple of 10 °C, at which ignition occurs in a layer of given thickness. Where ignition has been deemed to occur, from readings of the test thermocouple (see 4.3.1), the minimum ignition temperature shall be the lowest such temperature, rounded down to the nearest integral multiple of 10 °C, less 10 K.

The highest value of temperature at which ignition does not occur, or is deemed not to occur, shall also be recorded. This temperature shall not be more than 10 K lower than the minimum temperature at which ignition does occur, or is deemed to occur, and it shall be confirmed by at least three tests.

For the purpose of this standard, the tests shall be discontinued if ignition of a dust layer does not occur below a heated surface temperature of 400 °C. This fact shall be reported as the result of the test.

Times to obtain ignition, or times to reach the maximum temperature in the case of no ignition, shall be measured to the nearest 5 min from the time of placing the dust layer on to the heated surface, and shall be reported.

Where a dust layer fails to ignite at a temperature of less than 400 °C, the maximum duration shall be reported.

4.4 Test acceptance criteria

Results obtained by the same operator on different days and results obtained in different laboratories shall be considered unsatisfactory if they give ignition temperatures differing by more than 10 K in either case.

The validity of test results may sometimes be poor for reasons associated with the physical nature of the dusts and the behaviour of layers during test. When this occurs it shall be reported (see 4.5) and all results shall be accepted as equally valid.
The test report shall then include a brief description of the nature of the combustion following ignition, noting especially behaviour such as unusually rapid combustion or violent decomposition. Factors likely to affect the significance of the results shall also be reported; these include difficulties in the preparation of layers, distortion of layers during heating, decrepitation, melting and evidence of flammable gas generated during heating of the dust.

4.5 Reporting of results

The test report shall include the name, source and description (if not implicit in the name) of the material tested, the date and identification of the test, the ambient temperature and the density of the material as tested (see 4.2.6).

The report shall state that the determination of minimum ignition temperature of the dust layer has been carried out in accordance with this standard.

The ignition tests shall be reported in the manner shown in the following table (showing results in descending order of surface temperature rather than in the order in which tests were performed):

<table>
<thead>
<tr>
<th>Depth of layer (mm)</th>
<th>Surface temperature (°C)</th>
<th>Result of test</th>
<th>Time to ignition or to reach the highest value of temperature without ignition (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>180</td>
<td>Ignition</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>170</td>
<td>Ignition</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>160</td>
<td>No ignition</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>160</td>
<td>No ignition</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>160</td>
<td>No ignition</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>150</td>
<td>No ignition</td>
<td>62</td>
</tr>
</tbody>
</table>

The ignition temperature shall be recorded in accordance with 4.3.3 for each depth of layer.

In the example given in the above table the minimum ignition temperature for the 5 mm layer would be recorded as 170 °C.

Tests in which the heated surface temperature differed by more than ±20 K from the recorded minimum ignition temperature need not be reported.

4.6 Application of results

The values of minimum ignition temperature determined in accordance with method A of this standard apply to layers having the thicknesses used in the tests. Although for some materials it is possible to estimate the minimum temperatures of a heated surface for the ignition of layers of a given dust of intermediate or greater thickness, by linear interpolation or extrapolation of the test results plotted as the logarithm of the thickness versus the reciprocal of the minimum ignition temperature in kelvins, it is preferable to test with the required thickness.
NOTES

1 The above is the simplest predictive procedure which has some theoretical justification. More elaborate treatment based on thermal explosion theory will permit estimates for ignition of layers in other configurations, such as layers on curved surfaces. However, if it is desired to make accurate predictions for ignition under widely different conditions of exposure, in particular exposure to a symmetrical high temperature environment rather than to an unsymmetrical environment such as on a hot plate, it is preferable to use results obtained for an experimental procedure matching the different environment more closely such as ignition in an oven.

2 When extensive prediction is intended, it is desirable to determine ignition temperatures for more than two thicknesses of the layer and with an emphasis on thicker layers.

5 Method B: Dust cloud in a furnace at a constant temperature

5.1 Preparation of dust sample

The sample shall be prepared so as to be homogeneous and representative of the dust received for consideration.

The dust sample to be tested shall, in general, be able to pass through a woven metal wire cloth or a square hole perforated plate test sieve with a nominal size of aperture of 71 μm (for supplementary sizes, see ISO 565). If it is necessary to test a coarser dust, passing a test sieve with a nominal size of aperture up to 500 μm, the fact shall be stated in the test report.

Any apparent change noted in the properties of the dust during preparation of the sample, for example, by sieving or owing to temperature or humidity conditions, shall be stated in the test report.

5.2 Test apparatus

Details of construction of the test apparatus are shown in figures B.1 to B.10, and in table B.1. The heated silica tube of the furnace is vertical, and is open to the atmosphere at its lower end. The upper end connects, by a glass adaptor, to the dust holder. Dust is dispersed into the furnace by opening a solenoid valve, which releases compressed air from the reservoir. The furnace is mounted on a stand, enabling the lower end of the furnace tube to be readily observed.

A mirror is placed below the tube to enable the interior of the furnace tube to be viewed.

The thermocouples used are calibrated on a regular basis so as to maintain temperature measurements above 500 °C to ±1 %, and measurements below 300 °C to ±3 %.

After assembly of the test apparatus, its accuracy is compared with results obtained elsewhere for a powder such as lycopodium.

5.3 Procedure

5.3.1 Setting-up

The apparatus shall be set up in an enclosure from which dust and fumes can be extracted and which is free from draughts.
5.3.2 *Determination of minimum ignition temperature*

Place approximately 0.1 g of the dust in the dust holder. Set the temperature of the furnace to 500 °C, and the pressure of the air in the reservoir to 10 kPa (0.1 bar) above atmospheric pressure. Disperse the dust into the furnace. If ignition does not occur, repeat the test with fresh dust, having increased the temperature in steps of 50 K until ignition is obtained, or until a furnace temperature of 1000 °C is reached.

Once ignition is obtained, vary the mass of dust and the dispersion pressure of the air until the most vigorous ignition is apparent. Then, using the same mass and dispersion pressure, carry out further tests with the temperature reduced in steps of 20 K until no ignition is obtained after 10 attempts.

If ignition still occurs at 300 °C, reduce the temperature in steps of 10 K.

When no ignition is obtained, using this temperature reduction procedure, test again with the next lower temperature using lower and higher values of mass of dust and dispersion air pressure. If necessary, the temperature is reduced further until no ignition is again obtained after 10 attempts.

5.3.3 *Mass of dust*

The values of the mass of dust shall be selected from the following, with a tolerance of ±5%:

0.01, 0.02, 0.03, 0.05, 0.10, 0.20, 0.30, 0.50, 1.0, ..., g

5.3.4 *Air pressure*

The values of the air pressure in the reservoir, above that of atmospheric, for dispersion of the dust shall be selected from the following, with a tolerance of ±5%:

2.0, 3.0, 5.0, 10, 20, 30 and 50 kPa or alternatively, 0.02, 0.03, 0.05, 0.10, 0.20, 0.30 and 0.50 bar.

5.4 *Criterion of ignition*

Ignition occurs when a burst of flame is seen beyond the lower end of the furnace tube. A delay in time for ignition is acceptable. Sparks without flames do not constitute ignition.

5.5 *Minimum ignition temperature of a dust cloud*

The minimum ignition temperature is recorded as the lowest temperature of the furnace at which ignition was obtained using the stated procedures, minus 20 K for furnace temperatures above 300 °C, and minus 10 K for furnace temperatures at or below 300 °C.

If no ignition is obtained even when the furnace temperature is at 1000 °C, this fact shall be stated in the test report.
5.6 Reporting of results

The test report shall include the name, source and description (if not implicit in the name) of the material tested, the moisture content of the dust if it has been measured, the date and the identification of the test.

The report shall state that the determination of minimum ignition temperature of the dust cloud has been carried out in accordance with this standard.

The ignition temperature shall be recorded in accordance with 5.5.
Annex A
(normative)

Method A – Construction of a heated surface and measurement of temperature distribution on the surface

Provided the requirements of 4.2.1 are satisfied, the detailed construction of the heated surface is not critical. As an example, it may consist of a circular plate of suitable metal such as aluminum or stainless steel, provided with a "skirt" (see figure A.1) and it may be mounted on any suitable electrically heated boiling plate commercially available.

There are two ways of achieving a sufficiently uniform temperature distribution across the heated plate, the choice of which depends primarily on the heating device available. If the heater consists, for example, of exposed coiled filaments intended to run at red heat, there should be an air gap of about 10 mm between the heater and the plate so that heat transfer occurs by radiation and convection. If, however, the heater is designed for direct contact, so that heat transfer occurs mainly by conduction, the plate needs to be much thicker if hot spots are to be avoided. A thickness of not less than 20 mm is specified in 4.2.1.

The general arrangement shown in figure A.1 is self-explanatory. Although the indicating and controlling thermocouples may be inserted into the hot plate as shown in G and H in figure A.1, it is preferable to insert them in holes drilled radially from the edge of the plate and parallel to the surface, at a suitable depth for the junctions to be 1 mm ± 0,5 mm below the surface, as specified in 4.2.1. The base of the heated plate should be provided with feet in order to clear the support for the thermocouple stretched across the surface. This thermocouple is mounted between spring-loaded carriers on threaded vertical rods. The height of the thermocouple can be adjusted by means of nuts.

A suitable apparatus for measuring the temperature distribution across the heated surface is illustrated in figure A.4.

The measuring element consists of a fine thermocouple with the junction flattened and brazed to a disc of copper or brass foil, 5 mm in nominal diameter. This is placed at a measuring point, covered with a piece of suitable thermal insulating material, 5 mm in thickness and 10 mm to 15 mm in diameter and held by a vertical glass rod which moves freely in a tubular guide and to which a fixed load is applied.

Temperature measurements are made along two diameters at right angles and at points 20 mm apart, and recorded as in figure A.5. The thermocouple shall be allowed to reach a steady temperature at each point.

The measured surface temperature will usually be less than the surface temperature of the plate as set, to an extent which will depend on the detailed construction of the thermocouple. This difference is immaterial and can be ignored. The essential requirement is an accurate measurement of temperature differences rather than of actual values of temperature.
Figure A.1 – Diagram of hot plate (method A)
(drawn not to scale)

A  Heated plate
B  Skirt
C  Heater
D  Heater base
E  Heater connection to power supply
    and controller
F  Ring for dust layer
G  Plate thermocouple to controller
H  Plate thermocouple to recorder
I  Dust layer thermocouple to recorder
J  Screw adjustment for thermocouple height
K  Coil spring
Figure A.2 – Rings for forming dust layers (method A)
Figure A.3 – Typical temperature/time curves for ignition of dust layer on heated surface (method A)
Figure A.4 – Measurement of surface temperature (method A, annex A)
Maximum temperature difference over the whole plate 5 K
(Maximum deviation from set-point temperature 8 K)

Figure A.5 – Typical surface temperature distribution (method A)
# Annex B
(normative)

## Construction of a constant temperature furnace

### Table B.1 – Components of the apparatus (method B)
(See figures B.1 to B.10)

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Material</th>
<th>Section mm</th>
<th>Length mm</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Furnace housing</td>
<td>Stainless steel</td>
<td>0.9 thick</td>
<td>228</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Top cover</td>
<td>Mineral fibre</td>
<td>Ø 150</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Bottom cover</td>
<td>Mineral fibre</td>
<td>Ø 150</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>adaptor</td>
<td>Glass</td>
<td>–</td>
<td>–</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Tube</td>
<td>Silica</td>
<td>Ø 44</td>
<td>216</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>Collar</td>
<td>Stainless steel</td>
<td>Ø 90</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>washer</td>
<td>Mineral fibre</td>
<td>Ø 90</td>
<td>2 thick</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>Thermocouple mounting</td>
<td>Stainless steel</td>
<td>20 x 40</td>
<td>26</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>Thermocouple mounting</td>
<td>Stainless steel</td>
<td>30 x 50</td>
<td>23</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>knob</td>
<td>Stainless steel</td>
<td>Ø 25</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>11</td>
<td>knob</td>
<td>Stainless steel</td>
<td>Ø 18</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>12</td>
<td>washer</td>
<td>Mineral fibre</td>
<td>Ø 45</td>
<td>2 thick</td>
<td>1</td>
</tr>
<tr>
<td>13</td>
<td>washer</td>
<td>Mineral fibre</td>
<td>Ø 80</td>
<td>2 thick</td>
<td>1</td>
</tr>
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<td>14</td>
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<td>pin</td>
<td>Silver steel</td>
<td>Ø 1,5</td>
<td>6</td>
<td>4</td>
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<td>18</td>
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<td>Ø 4 outside</td>
<td>60</td>
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<td>–</td>
<td>Ø 2,4 inside</td>
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<td>nut M4 dome head</td>
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<td>washer</td>
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<td>–</td>
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<td>–</td>
<td>–</td>
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* Nickel chrome/chrome alumel.
** Iron alloy containing aluminium, cobalt and chromium.
For details of encircled items, refer to table 1.

Insulation – from item 5:
- 5 mm thick aluminous cement
- 25 mm thick mineral fibre
- 10 mm thick aluminous cement
- Remainder to be Kieselguhr

Figure B.1 – Furnace apparatus assembly (method B)
Silica tube with spiral groove on external surface.
Groove to take heating element of Kanthal "A" wire 0.2 SWG, total resistance 13 Ω.

Figure B.2 – Silica tube (method B)
NOTE

- Cover to be a close fit to body
- Hinge pins to be press-fit

Figure B.3 – Glass adaptor and dust holder (method B)
For details of encircled items, refer to table 1.

Dimensions in millimetres

Figure B.4 – Furnace housing 20 SWG stainless steel seamless (method B)
Figure B.5 – Top and bottom covers (method B)

Dimensions in millimetres
Three holes Ø 4.5 equally spaced

Chamfer 45° all around

Stainless steel collar, 1 piece

Medium diagonal knurl

M48 x 1.5 pitch thread to suit item 6

Stainless steel securing ring, 1 piece

Dimensions in millimetres

For details of encircled items, refer to table 1.

Figure B.6
Three holes Ø 4.5

Mineral fibre washer 2 mm thick 1 piece

Dimensions in millimetres

For details of encircled items, refer to table 1.

Figure B.7
For details of encircled items, refer to table 1.

Figure B.8

Dimensions in millimetres
Three legs equally spaced as shown welded in position

Dimensions in millimetres

Figure B.9 – Furnace stand base

Upper circular section stainless steel 16 SWG, legs Ø 10 outside stainless steel tube, feet Ø 25 stainless steel 16 SWG welded on to legs.
Figure B.10 – Dust dispersion system (method B)
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<table>
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