BS EN 15682-1:2013

BSI Standards Publication

Glass in building — Heat soaked thermally toughened alkaline earth silicate safety glass

Part 1: Definition and description

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National foreword

This British Standard is the UK implementation of EN 15682-1:2013.

The UK participation in its preparation was entrusted to Technical Committee B/520/1, Basic and transformed glass products.

A list of organizations represented on this committee can be obtained on request to its secretary.

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

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Glas im Bauwesen - Heißgelagertes thermisch vorgespanntes Erdalkali-Silicat-Einscheibensicherheitsglas - Teil 1: Definition und Beschreibung

This European Standard was approved by CEN on 30 May 2013.

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Foreword

This document (EN 15682-1:2013) has been prepared by Technical Committee CEN/TC 129 “Glass in Building”, the secretariat of which is held by IBN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2014, and conflicting national standards shall be withdrawn at the latest by January 2014.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

EN 15682 is composed of the following parts:

— EN 15682-1, *Glass in building — Heat soaked thermally toughened alkaline earth silicate safety glass — Part 1: Definition and description*

— EN 15682-2, *Glass in building — Heat soaked thermally toughened alkaline earth silicate safety glass — Part 2: Evaluation of conformity/Product standard*

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

Heat soaked thermally toughened alkaline earth silicate safety glass has a safer breakage behaviour when compared with annealed glass. It also has a known level of residual risk of spontaneous breakage arising from the possible presence of critical nickel sulphide (NiS) inclusions in the thermally toughened alkaline earth silicate glass.

NOTE 1 In this case it is about a statistical mean out of a big quantity of glass. It is impossible to determine separated subjects from it for a building where definitely no “break” produced by NiS occurs. The breaking of glass caused by other influences is not included herewith.

When used to offer protection under accidental human impact, heat soaked thermally toughened alkaline earth silicate safety glass also should be classified according to EN 12600.

NOTE 2 CEN/TC 129/WG 8 is producing standards for the determination of the design strength of glass and is preparing a design method.

1 Scope

This European Standard specifies the heat soak process system together with tolerances flatness, edgework, fragmentation and physical and mechanical characteristics of monolithic flat heat soaked thermally toughened alkaline earth silicate safety glass for use in buildings. Information on curved heat soak thermally toughened alkaline earth silicate safety glass is given in Annex B, but this product does not form part of this document.

Other requirements, not specified in this document, can apply to heat soaked thermally toughened alkaline earth silicate safety glass which is incorporated into assemblies, e.g. laminated glass or insulating units, or undergo an additional treatment, e.g. coating. The additional requirements are specified in the appropriate product standard EN 15682-2. In this case, heat soaked thermally toughened alkaline earth silicate glass does not lose its mechanical or thermal characteristics.

2 Normative references

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

EN 14178-1, *Glass in building - Basic alkaline earth silicate glass products - Part 1: Float glass*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply:

3.1
heat soaked thermally toughened alkaline earth silicate safety glass
glass within which a permanent surface compressive stress has been induced in order to give it greatly increased resistance to mechanical and thermal stress and prescribed fragmentation characteristics and which has a known level of residual risk of spontaneous breakage due to the presence of critical nickel sulphide (NiS) inclusions

Note 1 to entry: The mechanical properties, i.e. thermal durability and mechanical strength, and safety properties, i.e. fragmentation characteristics, are generated by the level of surface compression. These properties do not depend on the size of the pane.

3.2
residual risk
statistical risk of spontaneous breakage of heat soaked thermally toughened alkaline earth silicate safety glass due to the presence of critical nickel sulphide inclusions

3.3
flat heat soaked thermally toughened alkaline earth silicate safety glass
heat soaked thermally toughened alkaline earth silicate safety glass that has not been given a previously determined profile during manufacture

3.4
heat soaked enamelled thermally toughened alkaline earth silicate safety glass
heat soaked thermally toughened alkaline earth silicate safety glass which has a ceramic frit fired into the surface during the toughening process becoming an integral part of the glass after toughening

3.5
horizontal toughening
process in which the glass is supported on horizontal rollers

3.6
vertical toughening
process in which the glass is suspended by tongs

3.7
heat soak process
process which consists of a heating phase, a holding phase and a cooling phase, which in average should result in no more than one NiS related breakage per 400 tonnes of heat soaked thermally toughened alkaline earth silicate safety glass

4 Glass products

Heat soaked thermally toughened alkaline earth silicate safety glass is made from a monolithic alkaline earth silicate glass product generally corresponding to one of the following standards:

— coated glass according to EN 1096-1;

— basic alkaline earth silicate glass according to EN 14178-1.

5 Manufacturing processes

5.1 General

Heat soaked thermally toughened alkaline earth silicate safety glass is manufactured as follows:

Basic alkaline earth silicate glass products (see Clause 4) are cut to size, shaped and edge worked (see Clause 9).

The prepared glass panes are then thermally toughened (see 5.2).

The thermally toughened panes are then subjected to the heat soak process cycle.

After manufacture the heat soaked thermally toughened alkaline earth silicate glass shall comply with the fragmentation test (see Clause 10) and mechanical strength requirement (see 11.4).

5.2 Toughening process

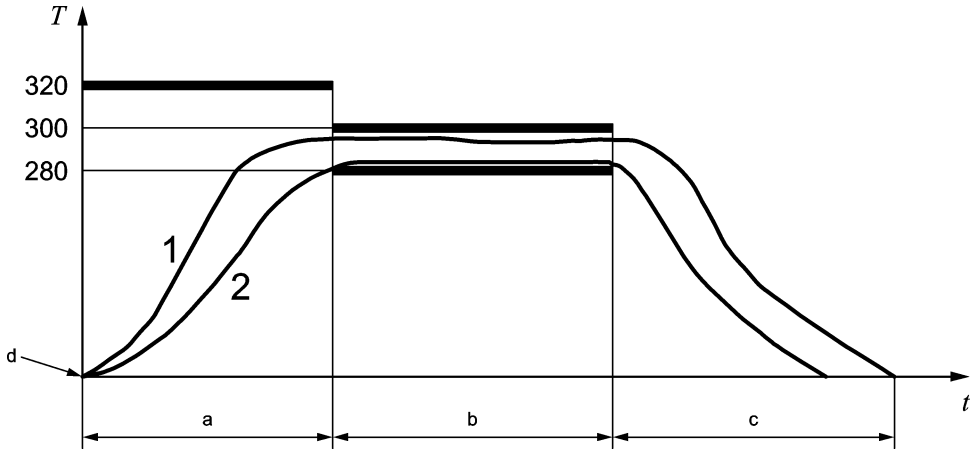
The cut, shaped and edge worked glasses are toughened. The horizontal or vertical toughened glass shall comply with the flatness criteria (see 8.3).

The thermally toughened alkaline earth silicate glass shall have a level of fragmentation that will ensure that after the glass has been through the heat soak process, and subsequently tested to the fragmentation test (see Clause 10), it shall comply with 10.5.

5.3 Heat soak process cycle

5.3.1 General

The heat soak process cycle consists of a heating phase, a holding phase and a cooling phase (see Figure 1).



Key

T	glass temperature at any point, °C	d	ambient temperature
t	time, h	a	heating phase
1	first glass to reach 280 °C	b	holding phase
2	last glass to reach 280 °C	c	cooling phase

Figure 1 — Heat soak process cycle

5.3.2 Heating phase

The heating phase commences with all the glasses at ambient temperature and concludes when the surface temperature of the last glass reaches 280 °C. The time to reach this temperature is defined in the calibration process. This time will be dependent on the size of the oven, the amount of glass to be treated, the separation between glasses and the heating system capacity.

The glass separation and rate of heating should be controlled to minimise the risk of glass breakage as a result of thermal stress.

To facilitate economic heating, the air temperature within the oven may exceed 320 °C. However, the glass surface temperature shall not be allowed to exceed 320 °C. The period of glass surface temperature in excess of 300 °C shall be minimised.

When the temperature of the glass exceeds 300 °C, care should be taken to ensure that the properties of the heat soaked thermally toughened alkaline earth silicate safety glass are not significantly altered, i.e. they continue to meet Clause 10.

5.3.3 Holding phase

The holding phase commences when the surface temperature of all the glasses has reached a temperature of 280 °C. The duration of the holding phase is minimum 2 h.

Precise oven control is necessary in order to ensure that the glass surface temperature shall be maintained in the range of 290 °C ± 10 °C during the holding phase.

5.3.4 Cooling phase

The cooling phase commences when the last glass to reach 280 °C has completed its holding phase, i.e. been held for two hours at 290 °C ± 10 °C. During this phase the glass temperature shall be brought down to ambient temperature.

The cooling phase can be concluded when the air temperature in the oven reaches 70 °C.

The rate of cooling should be controlled to minimise the risk of glass breakage as a result of thermal stress.

6 Heat soak process system

6.1 General

The heat soak process system consists of:

— the oven (see 6.2);

— the glass support (see 6.3);

— separation system (see 6.4).

The oven shall be calibrated (see 6.5 and Annex A), and this determines the method of operation of the heat soak process system during manufacture of heat soaked thermally toughened alkaline earth silicate safety glass.

6.2 Oven

The oven shall be heated by convection and shall allow an unhindered air circulation around each glass pane. In the event of glass breakage the airflow shall not be hindered. The airflow in the oven shall be led parallel to the glass surfaces.

The openings for the air ingress/egress should be designed to ensure that fragments of broken glass do not cause blockages.

6.3 Glass support

Glasses may be supported vertically or horizontally. The glasses shall not be fixed or clamped, they have to be supported to allow free movement.

NOTE Vertically means true vertical or up to 15° either side of true vertical.

The distance between glasses affects the airflow, heat exchange and the heating time. Glass to glass contact shall not be allowed.

6.4 Glass separation

The glasses shall be separated in a manner that does not hinder the airflow. The separators shall also not hinder the airflow, e.g. see Figure 2.

Dimensions in millimetres

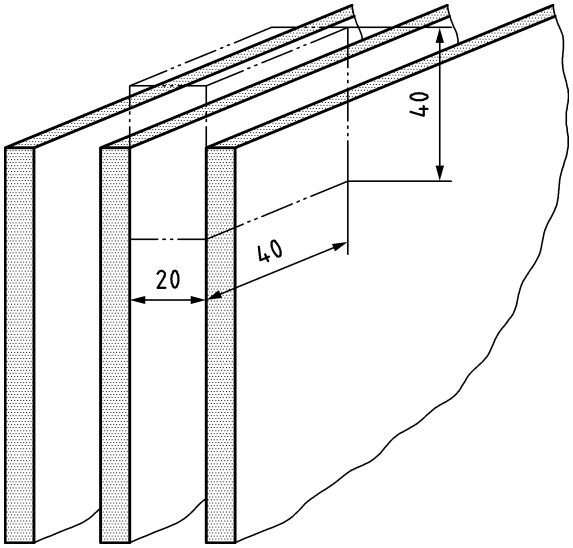


Figure 2 — Example of a vertical glass support

The minimum separation of the glasses shall be determined during the calibration of the oven (see 6.5 and Annex A).

Generally, a minimum separation of 20 mm is recommended. See Figure 3.

NOTE If glasses of very different sizes are put on the same stillage, they will require greater separation in order to prevent glass breakage when the furnace is opened after the heat soak process. The same applies to glasses with holes, notches and cut-outs.

Dimensions in millimetres

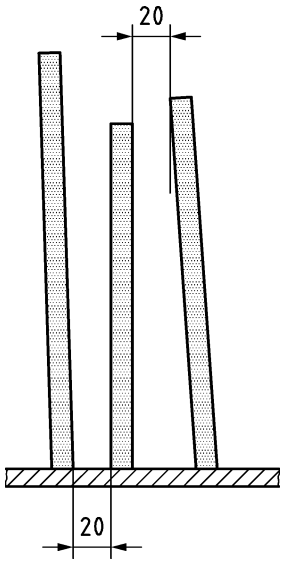


Figure 3 — Recommend separation between glass

The positioning of the separators, material of the manufacture and their shape shall be specified during the calibration test of the oven and shall be reproduced during the manufacturing process.

6.5 Calibration

The heat soak system, e.g. oven, glass separation, separators, etc., shall be calibrated (see Annex A).

The calibration shall determine the heating phase of the process, glass separation distance, the positioning, material and shape of separators, the type and positioning of stillage(s), and define the operating conditions for use during manufacture.

7 Fracture characteristics

In the event of breakage, heat soaked thermally toughened alkaline earth silicate safety glass fractures into numerous small pieces, the edges of which are generally blunt.

NOTE Fragmentation in service does not always correspond to that described in Clause 10, due to restraint from fixing or reprocessing (e.g. laminating), or due to the cause of fracture.

8 Dimensions and tolerances

8.1 Nominal thickness and thickness tolerances

The nominal thicknesses and thickness tolerances are those given in the relevant product standard (see Clause 4), some of which are reproduced in Table 1.

Table 1 — Nominal thicknesses and thickness tolerances

Dimensions in millimetres

Nominal thickness d	Thickness tolerances
4	±0,2
5	±0,2
6	±0,2
8	±0,3
10	±0,3
12	±0,3
15	±0,5

The thickness of a pane shall be determined as for the basic product. The measurement shall be taken at the centres of the four sides, and away from the area of any tong marks (see Figure 6), which may be present.

8.2 Width and length (sizes)

8.2.1 General

When heat soaked thermally toughened alkaline earth silicate safety glass dimensions are quoted for rectangular panes, the first dimension shall be the width, *B*, and the second dimension the length, *H*, as shown in Figure 4. It shall be made clear which dimension is the width, *B*, and which is the length, *H*, when related to its installed position.

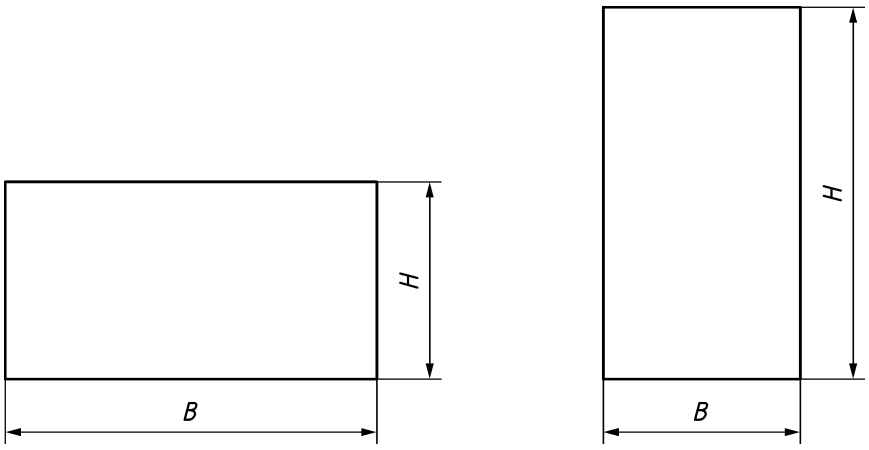


Figure 4 — Examples of width, B, and length, H, relative to the pane shape

8.2.2 Maximum and minimum sizes

For maximum and minimum sizes, the manufacturer shall be consulted.

8.2.3 Tolerances and squareness

The nominal dimensions for width and length being given, the finished pane shall not be larger than a prescribed rectangle resulting from the nominal dimensions increased by the tolerance, *t*, or smaller than a prescribed rectangle reduced by the tolerance, *t*. The sides of the prescribed rectangles are parallel to one another and these rectangles shall have a common centre (see Figure 5). The limits of squareness shall be determined by the prescribed rectangles. Tolerances are given in Table 2.

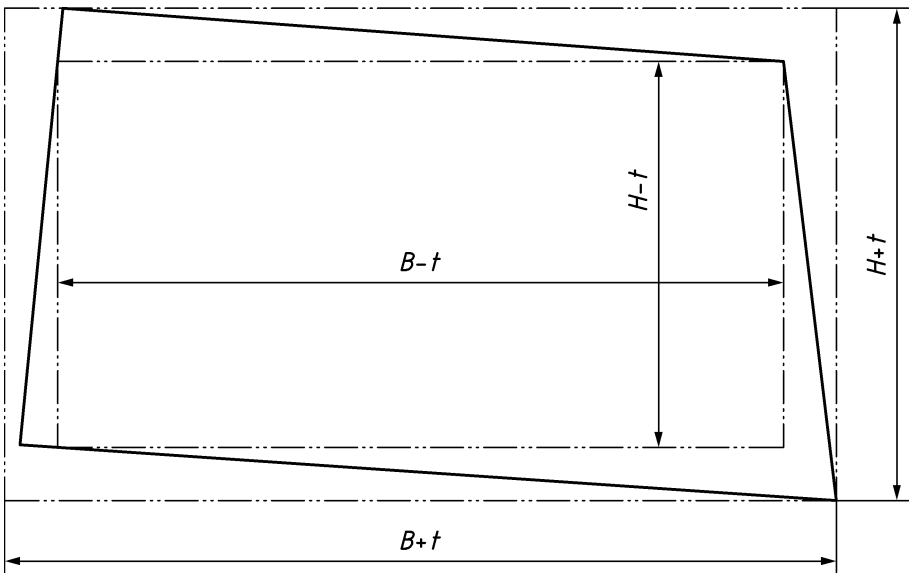


Figure 5 — Tolerance limits for dimensions of rectangular panes

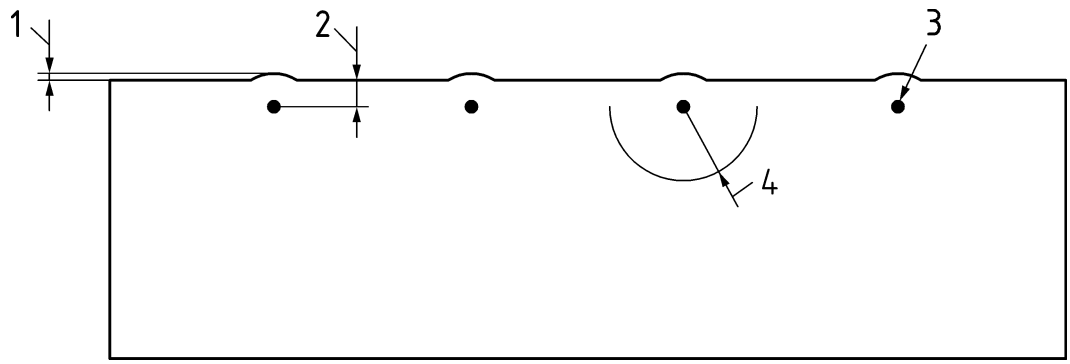
Table 2 — Tolerances on width, *B*, and length, *H*

Dimensions in millimetres

Nominal dimension of side, *B* **or** *H*	**Tolerance,** *t*	
	nominal glass thickness, *d* ≤ 12	**nominal glass thickness,** *d* > 12
≤ 2 000	±2,5 (horizontal toughening) ± 3,0 (vertical toughening)	±3,0
> 2 000 to 3 000	±3,0	±4,0
> 3 000	±4,0	±5,0

8.2.4 Edge deformation produced by vertical toughening

The tongs used to suspend the glass during toughening can result in surface depressions, known as tong marks (see Figure 6). The centres of the tong marks may be situated up to a maximum of 20 mm in from the edge. A deformation of the edge less than 2 mm can be produced in the region of the tong mark and there can also be an area of optical distortion. These deformations shall be included in the tolerances in Table 2.



Key

1 deformation
2 up to 20 mm
3 tong mark
4 100 mm radius maximum area of optical distortion

Figure 6 — Tong mark deformation

8.3 Flatness

8.3.1 General

By the very nature of the toughening process, it is not possible to obtain a product as flat as annealed glass. The difference depends on the nominal thickness, the dimensions and the ratio between the dimensions. Therefore a distortion known as overall bow may occur. There are two kinds of bow (see Figure 7):

— overall or general bow;

— local bow.

NOTE 1 Overall bow can, in general, be accommodated by the framing system.

NOTE 2 Local bow needs to be allowed for in the glazing materials and the weather seals.

8.3.2 Measurement of overall bow

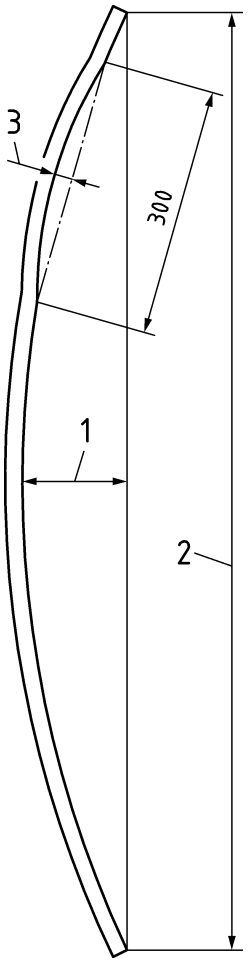
The pane of glass shall be placed in a vertical position and supported on its longer side by two load-bearing blocks at the quarter points (see Figure 8).

The deformation shall be measured along the edges of the glass and along the diagonals, as the maximum distance between a straight metal ruler, or a stretched wire, and the concave surface of the glass (see Figure 7).

The value for the bow is then expressed as the deformation, in millimetres, divided by the measured length of the edge of the glass, or diagonal, in millimetres, as appropriate.

The measurement shall be carried out at ambient temperature.

Dimensions in millimetres

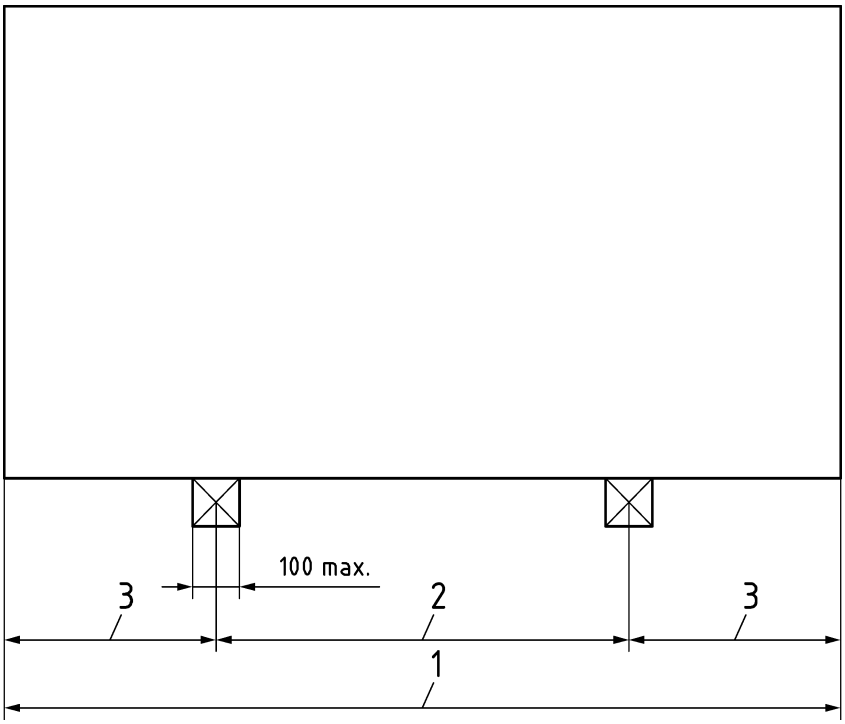


Key

1 deformation for calculating overall bow
2 *B*, or *H*, or diagonal length
3 local bow

Figure 7 — Representation of overall and local bow

Dimensions in millimetres



Key

1 *B* or *H*

2 (*B* or *H*)/2

3 (*B* or *H*)/4

Figure 8 — Support conditions for the measurement of overall bow

8.3.3 Measurement of local bow

Local bow can occur over relatively short distances on the edges of the glass. Local bow shall be measured over a limited length of 300 mm by using a straight ruler, or a stretched wire, parallel to the edge at a distance of 25 mm from the edge of the glass (see Figure 7).

Local bow is expressed as mm/300 mm length.

8.3.4 Limitation on overall and local bow

The maximum allowable values for the overall bow, when measured according to 8.3.2, and local bow, when measured according to 8.3.3, for glass without holes and/or notches and/or cut-outs shall not exceed those given in Table 3.

Table 3 — Maximum values for overall and local bow

Toughening process	**Type of glass**	**Maximum values**	
		Overall bow mm/m	**Local bow** mm/300 mm
Horizontal	Float to EN 14178–1	3,0	0,3
Vertical	Float to EN 14178–1	5,0	1,0

9 Edge work, holes, notches and cut-outs

9.1 Warning

WARNING — Heat soaked thermally toughened alkaline earth silicate safety glass should not be cut, sawed, drilled or edge worked after toughening.

9.2 Edge working of glass for toughening

Every glass that is to be thermally toughened shall be edge worked prior to toughening.

The simplest type of edge working is the arrissed edge (see Figure 9). Other common types are shown in Figure 10 to Figure 12. For specialist edge work, such as 'water jet cutting', the manufacturers should be consulted.

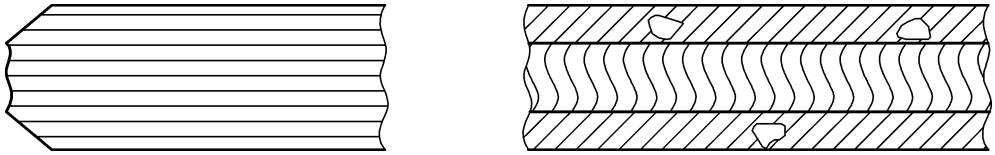


Figure 9 — Arrissed edge (with blank spots)

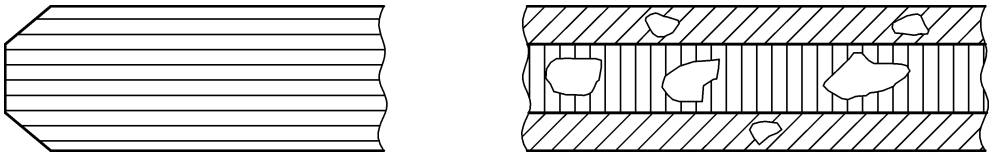


Figure 10 — Ground edge (with blank spots)

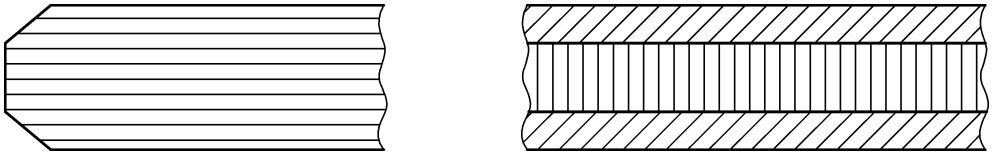


Figure 11 — Smooth ground edge (no blank spots)

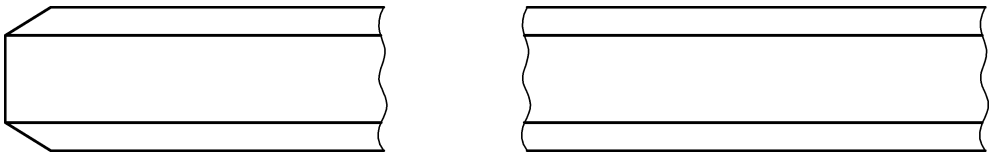


Figure 12 — Polished edge

9.3 Profiled edges

Various other edge profiles can be manufactured with different types of edgework.

9.4 Round holes

9.4.1 General

This standard considers only round holes in glass that is not less than 4 mm nominal thickness. The manufacturers should be consulted about edge working of holes.

9.4.2 Diameter of holes

The diameter of holes, ∅, shall not, in general, be less than the nominal thickness of the glass. For smaller holes, the manufacturers should be consulted.

9.4.3 Limitations on position of holes

In general, the limitations on hole positions relative to the edges of the glass pane, the corners of the glass pane and to each other depends on:

— the nominal glass thickness (*d*);

— the dimensions of the pane (*B,H*);

— the hole diameter (∅);

— the shape of the pane;

— the number of holes.

The recommendations given below are those which are normally available and are limited to panes with a maximum of four holes.

a) The distance, *a*, of the edge of a hole to the glass edge should be not less than 2*d*.

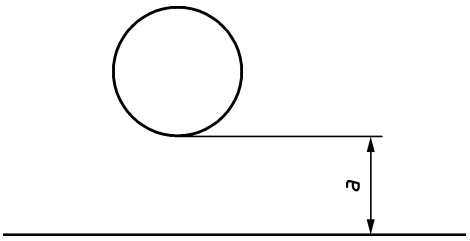


Figure 13 — Relationship between hole and edge of pane

b) The distance, *b*, between the edges of two holes should be not less than 2*d*.

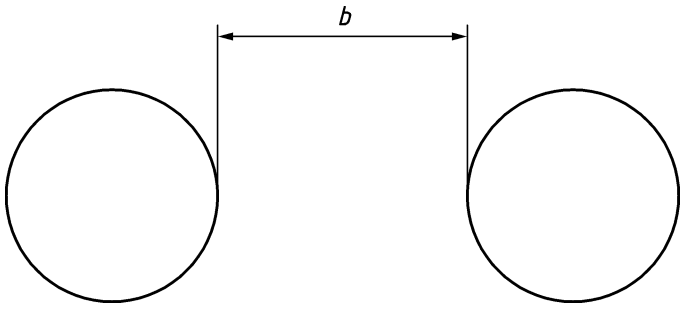


Figure 14 — Relationship between two holes

c) The distance, *c*, of the edge of a hole to the corner of the glass should be not less than 6*d*.

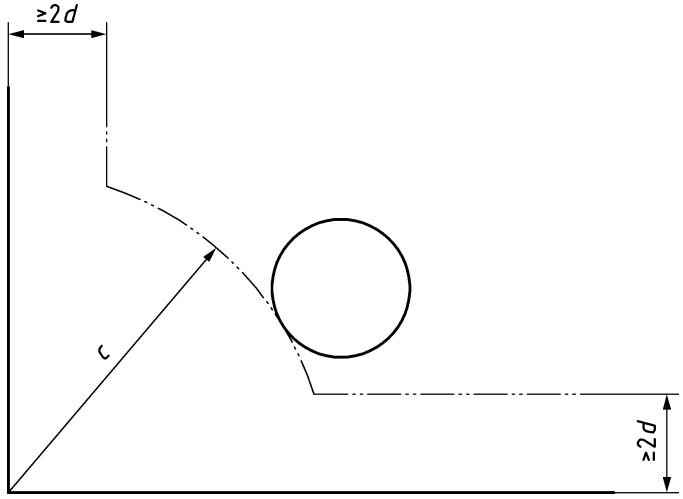


Figure 15 — Relationship between hole and corner of pane

NOTE If one of the distances from the edge of the hole to the edge of the glass is less than 35 mm, it can be necessary to position the hole asymmetrically with respect to the comer.

9.4.4 Tolerances on hole diameters

The tolerances on hole diameters shall be as given in Table 4.

Table 4 — Tolerances on hole diameters

Dimensions in millimetres

Nominal hole diameter, Ø	Tolerances
4 to 20	±1,0
> 20 to 100	±2,0
> 100	Consult the manufacturer

9.4.5 Tolerances on position of holes

The tolerances on positions of holes are the same as the tolerances on the width, *B*, and the length, *H* (see Table 2). The positions of holes are measured in two directions at right angles (*x*- and *y*-axes) from a datum point to the centre of the holes. The datum point is generally chosen as a real or virtual corner of the pane (see Figure 16 for examples).

The position of a hole (*X,Y*) *is* ($x \pm t$, $y \pm t$), where *x and y* are the required dimensions and *t* is the tolerance from Table *2.*

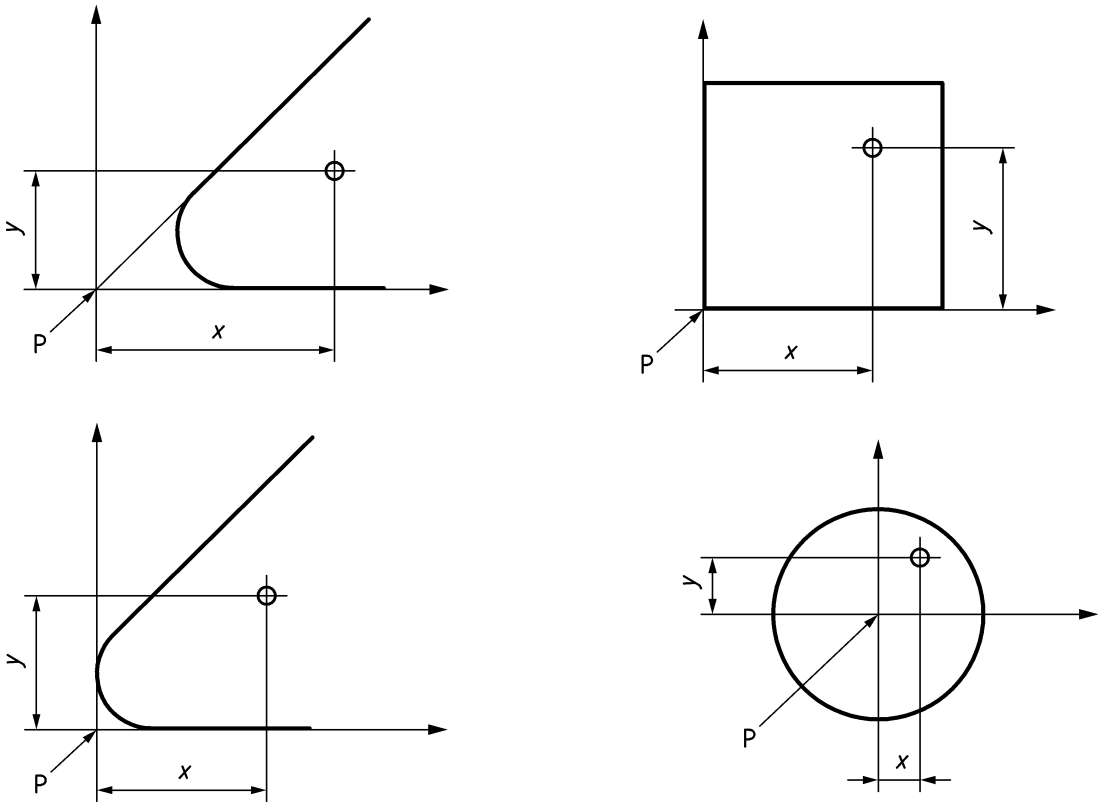


Figure 16 — Examples of the positioning of holes relative to the datum point

9.5 Notches and cut-outs

Many configurations of notches and cut-outs can be supplied.

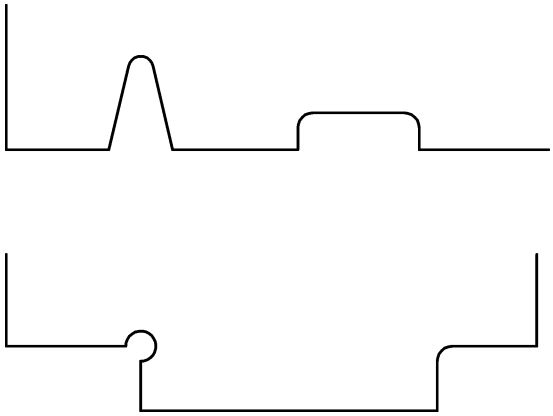


Figure 17 — Examples of notches and cut-outs

The manufacturer should be consulted about edge working of notches and cut-outs.

9.6 Shaped panes

Many non-rectangular shapes can be manufactured and manufacturers should be consulted.

10 Fragmentation test

10.1 General

The fragmentation test determines whether the glass breaks in the manner prescribed for a heat soaked thermally toughened alkaline earth silicate safety glass.

10.2 Dimensions and number of test specimens

The dimensions of the test specimens shall be 360 mm × 1 100 mm, without holes, notches or cut-outs.

Five specimens shall be tested.

10.3 Test procedure

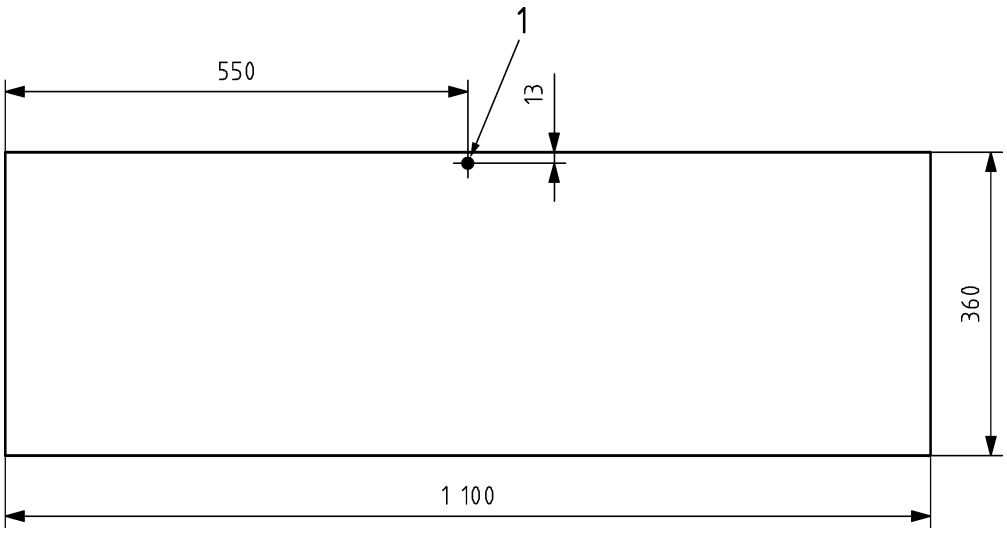
Each test specimen shall be impacted, using a pointed steel tool, at a position 13 mm in from the longest edge of the test specimen at the mid-point of that edge, until breakage occurs (see Figure 18).

NOTE The fragmentation characteristics of heat soaked thermally toughened alkaline earth silicate glass are unaffected by temperatures between – 50 °C and + 100 °C.

Examples of steel tools are a hammer of about 75 g mass, a spring loaded centre punch, or other similar appliance with a hardened point. The radius of curvature of the point should be approximately 0,2 mm.

The test specimen shall be laid flat on a table without any mechanical constraint. In order to prevent scattering of the fragments, the specimen shall be simply held at the edges, e.g. by a small frame, adhesive tape etc., so that the fragments remain interlocked after breakage yet extension of the specimen is not hindered.

Dimensions in millimetres



Key

1 impact point

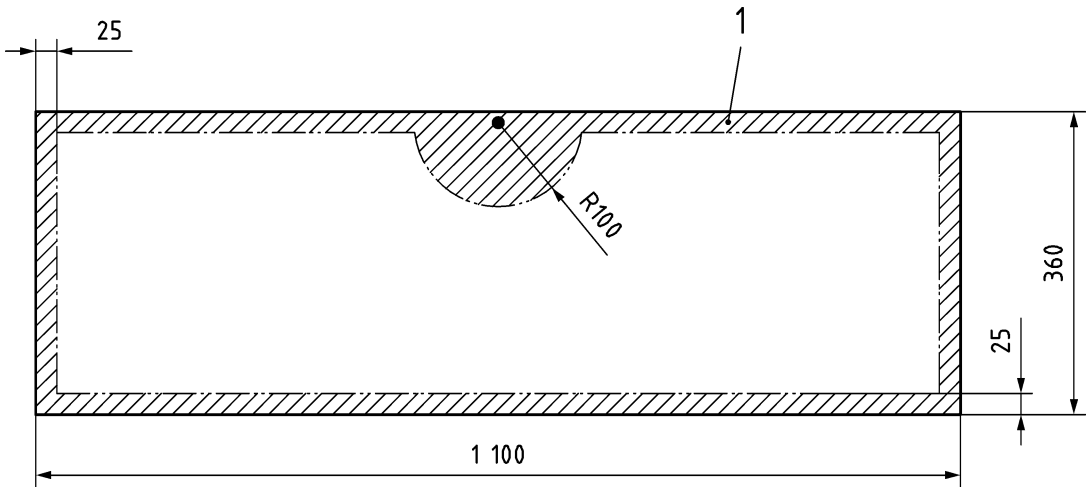
Figure 18 — Position of impact point

For heat soaked thermally toughened alkaline earth silicate safety glass manufactured by vertical toughening, the impact point shall not be on the tong mark edge.

10.4 Assessment of fragmentation

The particle count and measuring of the dimensions of the largest particle shall be made between 4 min to 5 min after fracture. An area of radius 100 mm, centred on the impact point, and a border of 25 mm, round the edge of the test specimen (see Figure 19), shall be excluded from the assessment.

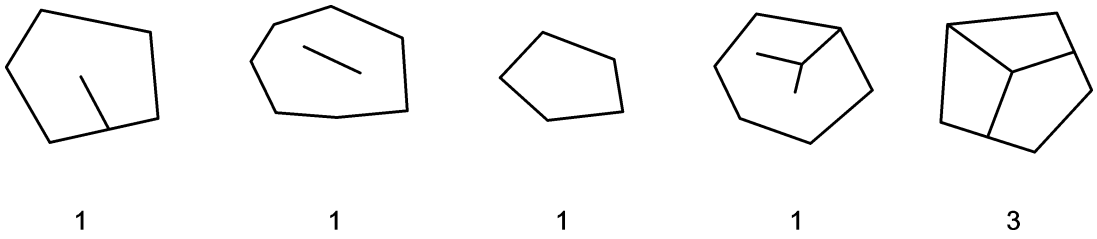
The particle count shall be made in the region of coarsest fracture (the aim being to obtain the minimum value). The particle count shall be made by placing a mask of (50 ± 1) mm × (50 ± 1) mm on the test piece (see Annex C). The number of crack-free particles within the mask shall be counted. A particle is 'crack-free' if it does not contain any cracks, which run from one edge to another (see Figure 20).



Key

1 excluded area

Figure 19 — Area to be excluded from the particle count determination and largest particle measurement



Key

1 and 3 particle(s)

Figure 20 — Examples of crack-free particles and the assessment regarding the number

In the particle count, all particles wholly contained within the area of the mask shall be counted as one particle each and all the particles, which are partially within the mask shall be counted as 1/2 particle each (see Annex C).

10.5 Minimum values from the particle count

In order to classify a glass as a heat soaked thermally toughened alkaline earth silicate safety glass, the particle count of each test specimen shall not be less than the values given in Table 5.

Table 5 — Minimum value of particle count

Nominal thickness (*d*) mm	**Minimum value of particle count**
4 to 12	40
15	30

10.6 Selection of the longest particle

The longest particle shall be chosen from the body of the test specimen. It shall not be in the excluded area (see 10.4).

10.7 Maximum length of longest particle

In order to classify the glass as heat soaked thermally toughened alkaline earth silicate safety glass, the length of the longest particle shall not exceed 100 mm.

11 Other physical characteristics

11.1 Optical distortion

11.1.1 Heat soaked thermally toughened alkaline earth silicate safety glass produced by vertical toughening

The tong marks can produce additional optical distortion which is generally in an area of radius 100 mm centred on the tong mark (see Figure 6).

11.1.2 Heat soaked thermally toughened alkaline earth silicate safety glass produced by horizontal toughening

While the hot glass is in contact with the rollers during the toughening process, a surface distortion is produced by a reduction in surface flatness, known as 'roller wave'. Roller wave is generally noticed in reflection. Glass, which is thicker than 8 mm, can show signs of small imprints in the surface ('roller pick-up').

11.2 Anisotropy (iridescence)

The toughening process produces areas of different stress in the cross section of the glass. These areas of stress produce a bi-refringent effect in the glass, which is visible in polarised light.

When heat soaked thermally toughened alkaline earth silicate safety glass is viewed in polarised light, the areas of stress show up as coloured zones, sometimes known as 'leopard spots'.

Polarised light occurs in normal daylight. The amount of polarised light depends on the weather and the angle of the sun. The bi-refringent effect is more noticeable either at a glancing angle or through polarised spectacles.

11.3 Thermal durability

The mechanical properties of heat soaked thermally toughened alkaline earth silicate safety glass are unchanged for continuous service up to 250 °C and are unaffected by sub-zero temperatures. Heat soaked thermally toughened alkaline earth silicate safety glass is capable of resisting both sudden temperature changes and temperature differentials up to 200 K.

11.4 Mechanical strength

The value of mechanical strength can only be given as a statistical value associated with a particular probability of breakage and with a particular type of loading, i.e. four point bending test according to EN 1288-3.

The mechanical strength values apply to quasi-static loading over a short time, e.g. wind loading, and relate to a 5 % probability of breakage at the lower limit of the 95 % confidence interval. The values for different types of glass are listed in Table 6.

Table 6 — Minimum values for the mechanical strength of heat soaked thermally toughened alkaline earth silicate safety glass

Type of glass	Minimum Values for mechanical strength N/mm^2
clear tinted coated	120
Enamelled (based on the enamelled surface in tension)	75

NOTE The values in Table 6 represent the strength of heat soaked thermally toughened alkaline earth silicate safety glass (4 mm and thicker) that meet the requirements of 10.5.

11.5 Classification of performance under accidental human impact

Heat soaked thermally toughened alkaline earth silicate safety glass can be classified, as to its performance under accidental human impact, by testing in accordance with EN 12600.

12 Marking

Heat soaked thermally toughened alkaline earth silicate safety glass conforming to this European Standard shall be permanently marked. The marking shall give the following information:

— name or trademark of manufacturer;

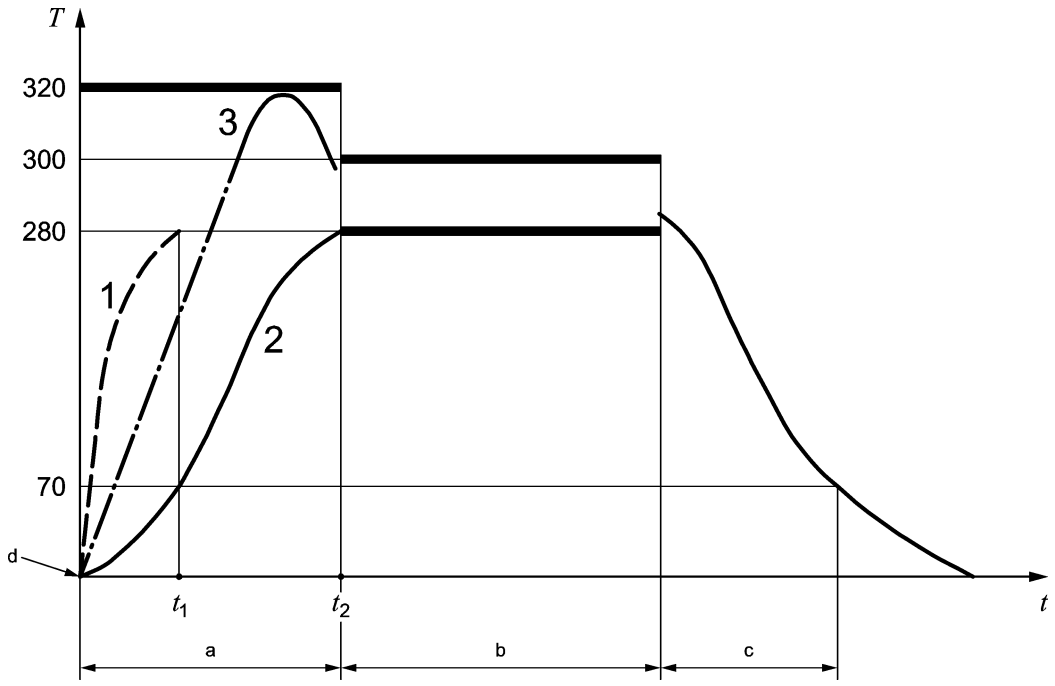
— number of this European Standard, i.e. EN 15682-1.

Annex A
(normative)

Heat soak process system calibration test

A.1 Calibration criteria

The heat soak process system shall comply with the time/temperature regime as shown in Figure A.1. The system shall be capable of meeting in the regime at both 100 % and 10 % load.



Key

T	Glass temperature at any point, °C	3	glass temperature
t	time, h	d	ambient temperature
t_1	time for the first glass to reach 280 °C	a	heating phase
t_2	time for the last glass to reach 280 °C	b	holding phase
1	first glass to reach 280 °C	c	cooling phase
2	last glass to reach 280 °C		

Figure A.1 — Time/temperature regime as calibration criteria

A.2 Loading of oven and position for glass surface temperature measurement

Figure A.2 to Figure A.9 show the appropriate pattern of stillage(s) loading and thermocouple placements for ovens, which take 1, 2, 6, 8 or 9 stillage(s). Thermocouples should not be fixed nearer to the edge than 25 mm.

The duration of the heating phase is dependent on the capacity of the oven and the level of load being used.

NOTE Full load will be dependent on glass size, thickness and oven volume. Generally, full load will be defined based on 6 mm or 8 mm thickness.

The separation of the glasses shall be specified as shall also the type, position, material and shape of the separators. The separation of the glasses shall be constant on the stillage(s).

The minimum separation used during calibration is the minimum separation that can be employed during the manufacturing process.

Generally, a minimum separation of 20 mm is recommended.

A.3 Procedure

The measurements of the air temperature in the oven and the glass surface temperatures shall be carded out when the furnace is fully loaded. They shall be repeated for a 10 % loading.

The oven air temperature is monitored by a control element, which is located near the air egress. The measurement of the glass surface temperatures is carried out by thermocouples that are stuck, with good thermal contact, to the glass surfaces.

At the beginning of the calibration, the air temperature in the oven shall not exceed 35 °C.

During the heating phase the oven shall be heated up until the last glass surface temperature reaches 280 °C.

During the heating phase the glass temperature shall not exceed 320 °C at any place.

During the heating phase the following parameters shall be recorded:

— T_c temperature of the control element (at any time);

— t_1 time for the first thermocouple an a glass to reach a temperature of 280 °C;

— T_{c1} temperature of control element at time t_1;

— t_2 time for the last thermocouple an a glass to reach a temperature of 280 °C;

— T_{cmax} maximum temperature of the control element during the heating phase;

— t_{cmax} time at which T_{cmax} occurs;

— T_{glass} temperature of the glass surfaces, measured by the thermocouples (at any time) (see Figure A.2 to Figure A.9).

The holding phase starts at time t_2 and shall last for a period of 2 hours. The glass surface temperatures T_{glass} shall remain within the range 290 °C ± 10 °C. The control element temperature T_c shall be recorded.

The cooling phase starts at time t_2 + 2 h. The control element temperature T_c shall be recorded. The oven can be opened when T_c reaches 70 °C.

A.4 Records

The test parameters:

— t_1, T_{c1},

— t_{cmax}, T_{cmax},

— t_2,

— T_c, T_{glass},

— glass separation distance,

— separator position, material, shape,

— stillage(s) configuration,

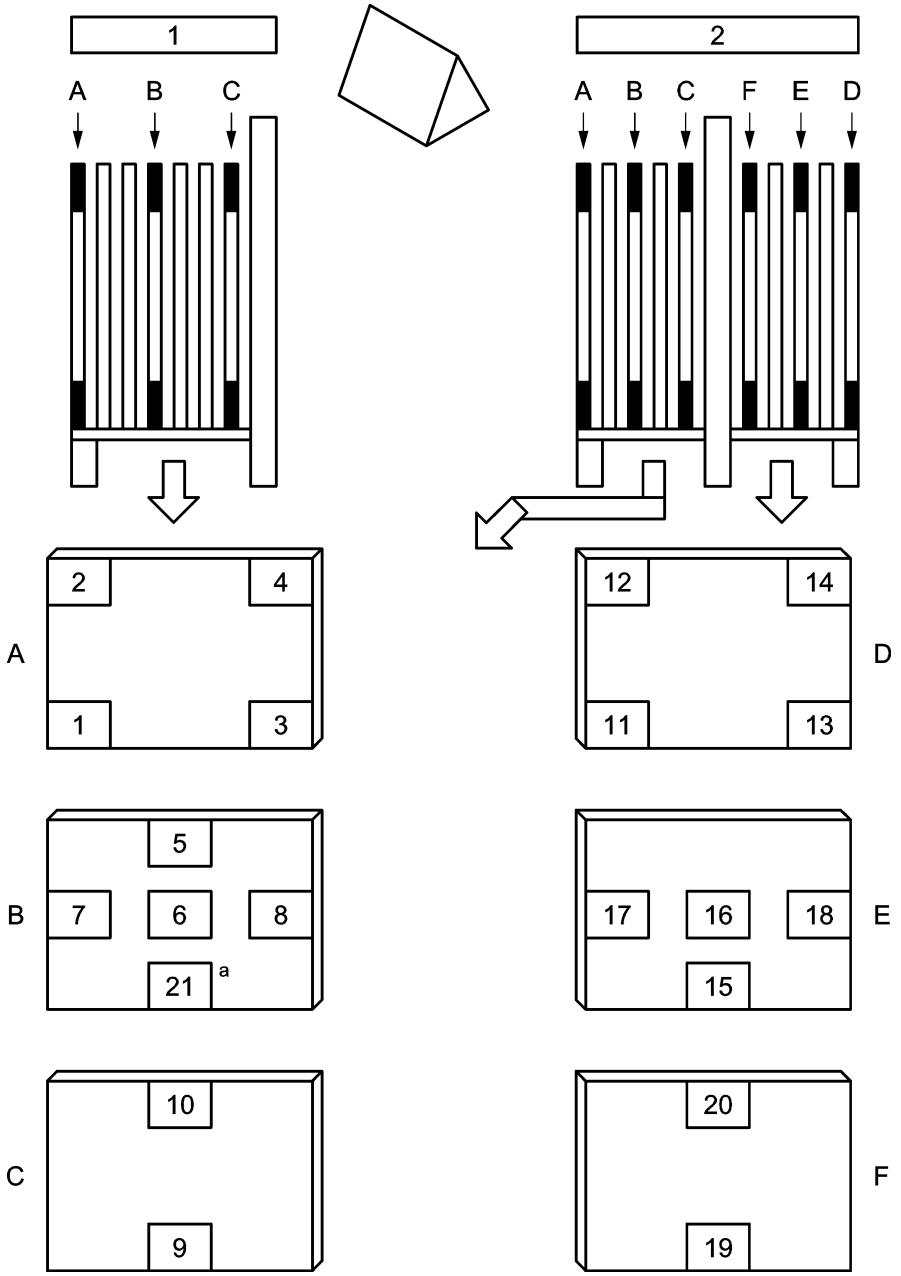
shall be recorded.

A.5 Interpretation of the calibration test

If the conditions for temperatures laid down in A.1 are not met then the oven shall not be regarded as calibrated.

Only ovens which meet the calibration criteria as laid down in A.1 at full and 10 % load may be used for the heat soak process cycle during manufacture. The longer of the two times, $t_{2,1}$ (full load) or $t_{2,2}$ (10 % load), shall be used for regular production.

The heat soak process system used for manufacture shall comply with the details of the system as calibrated.

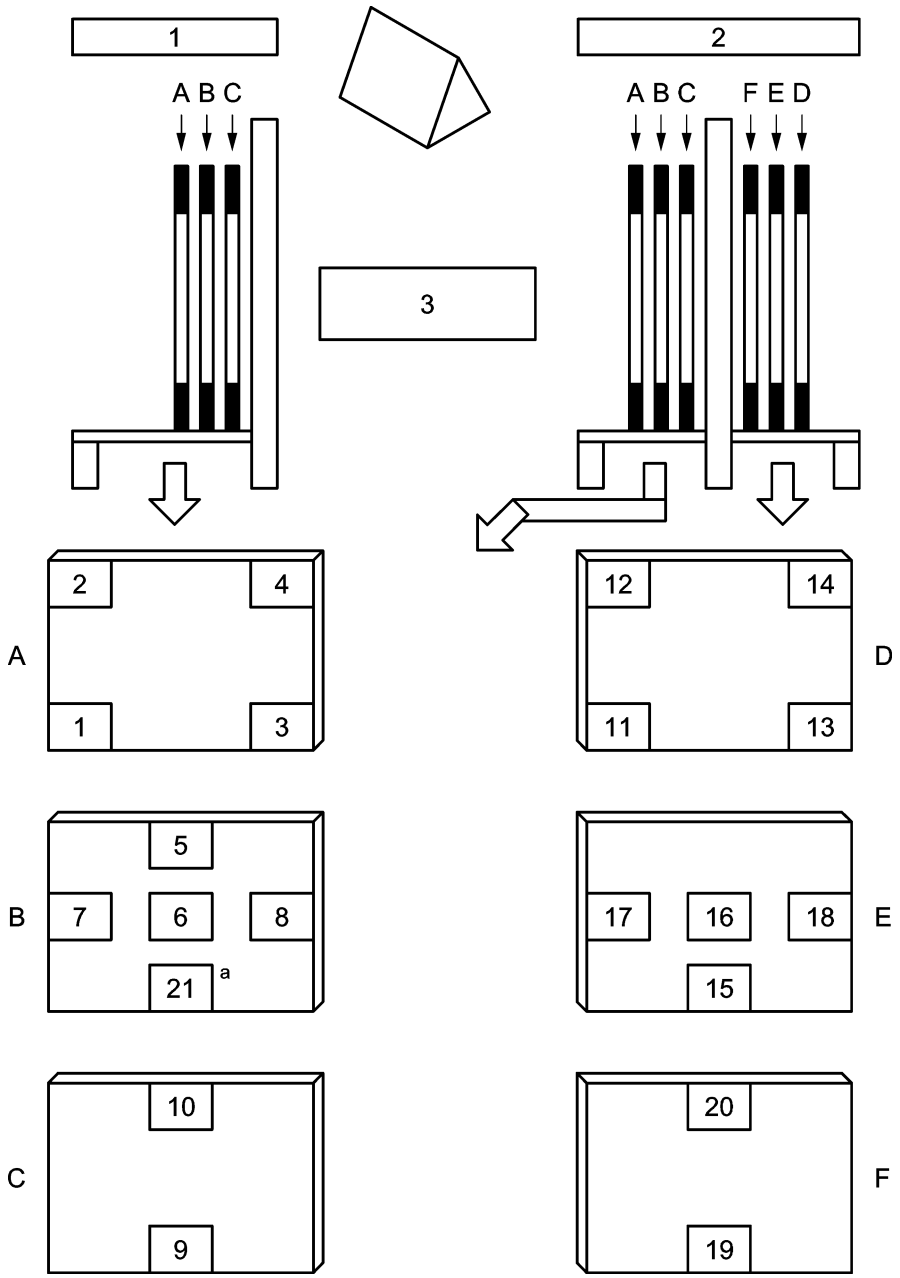


Thermocouples should not be fixed nearer to the edge than 25 mm.

Key

A,B,C	glass panes
1,2,3,..	thermocouple positions
a	is only used for mono side stillages
1	mono side stillage
2	double sided stillage

Figure A.2 — 1st category – 1 stillage – full load

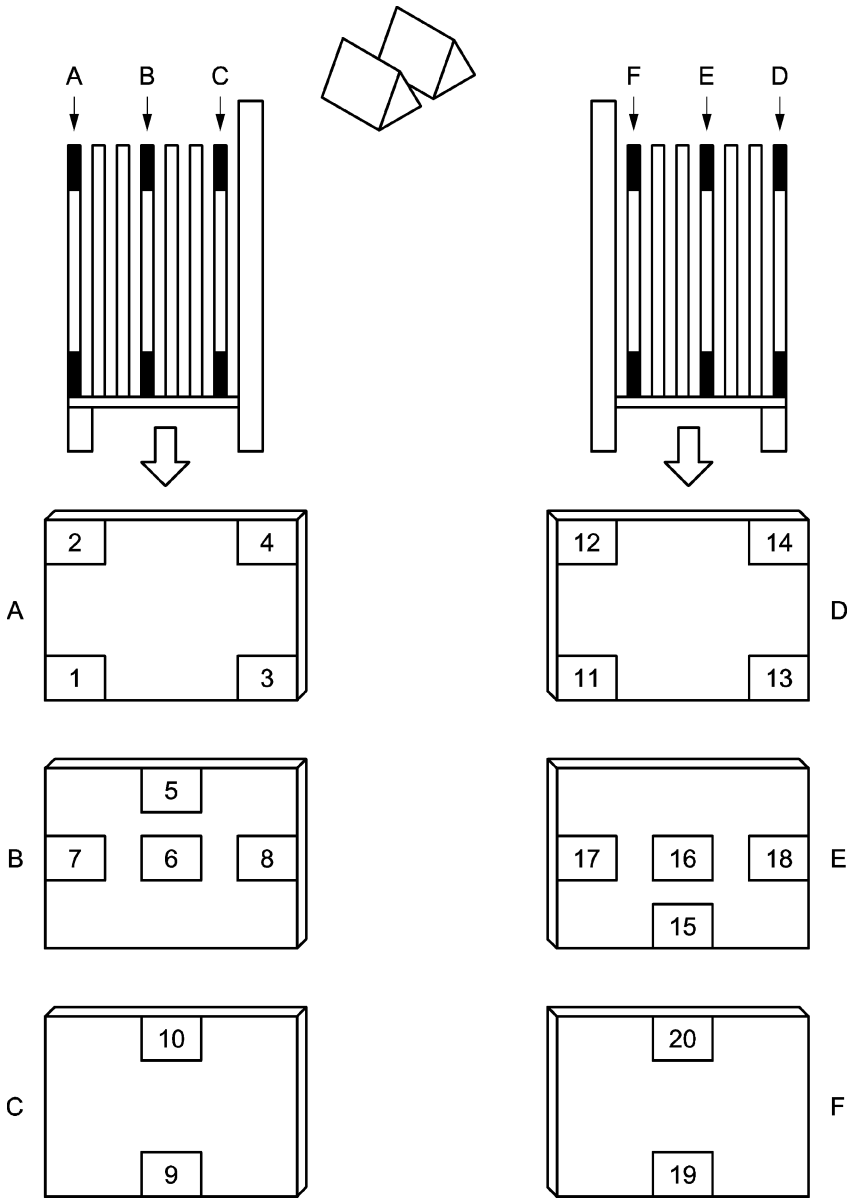


Thermocouples should not be fixed nearer to the edge than 25 mm.

Key

A,B,C	glass panes
1,2,3,..	thermocouple positions
[a]	is only used for mono side stillages
1	mono side stillage
2	double sided stillage
3	on the stillage: minimum 3 glasses in parallel side by side

Figure A.3 — 1st category – 1 stillage – 10 % load



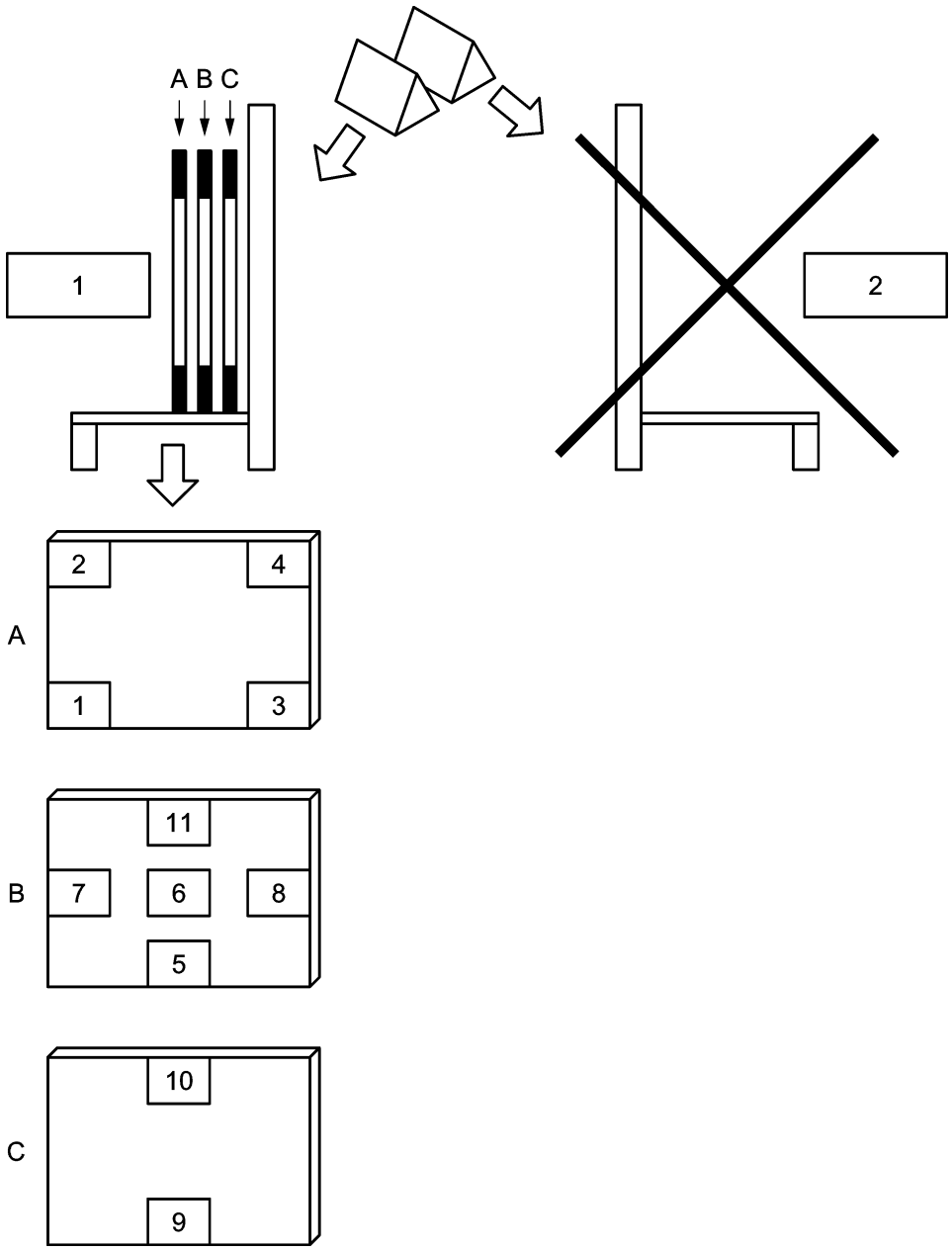
Thermocouples should not be fixed nearer to the edge than 25 mm.

Key

A,B,C glass panes

1,2,3,.. thermocouple positions

Figure A.4 — 2nd category – 2 mono side stillages – full load

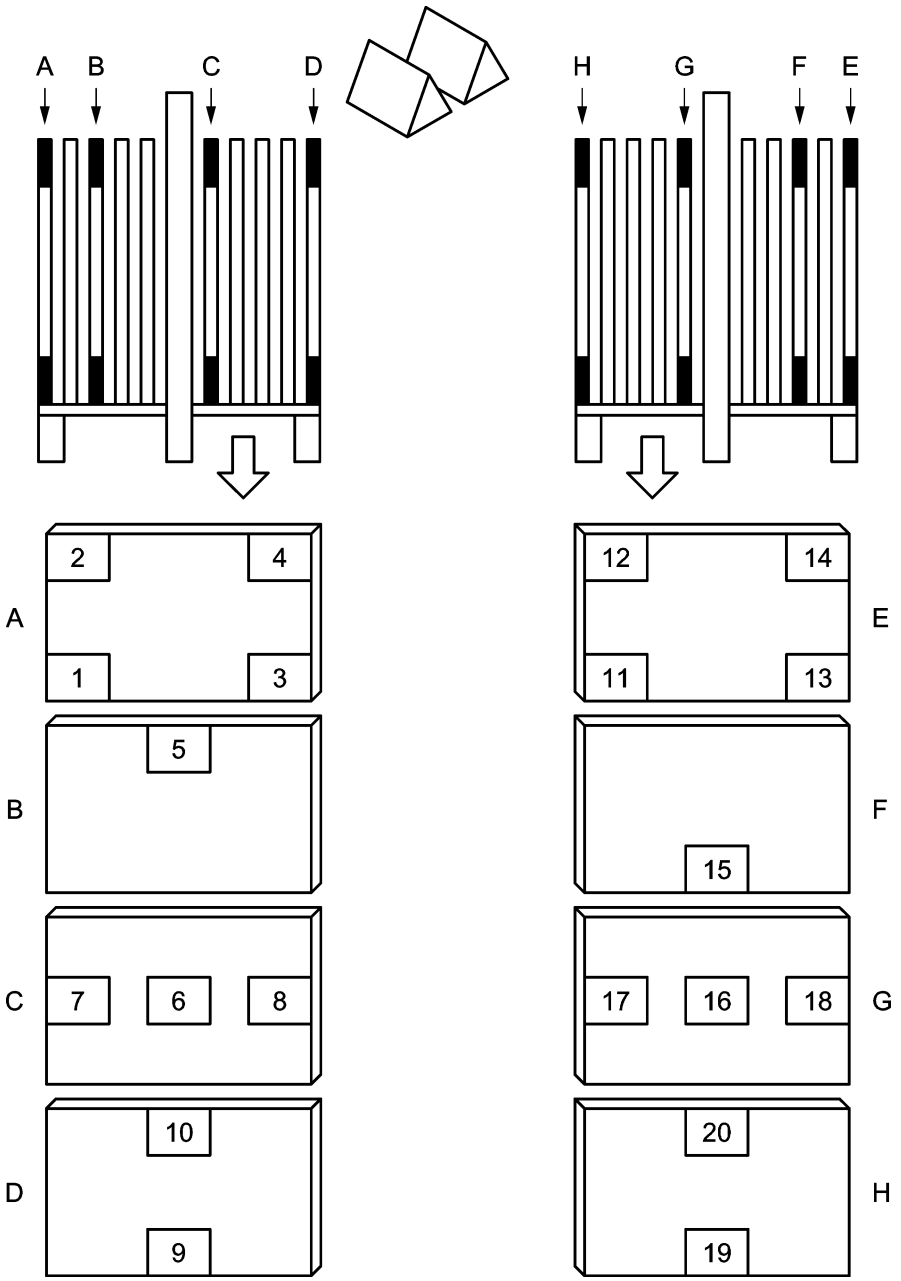


Thermocouples should not be fixed nearer to the edge than 25 mm.

Key

A,B,C	glass panes
1,2,3,..	thermocouple positions
1	1st stillage: minimum 3 glasses in parallel
2	Don't use the 2nd stillage.

Figure A.5 — 2nd category – 2 mono side stillages – 10 % load



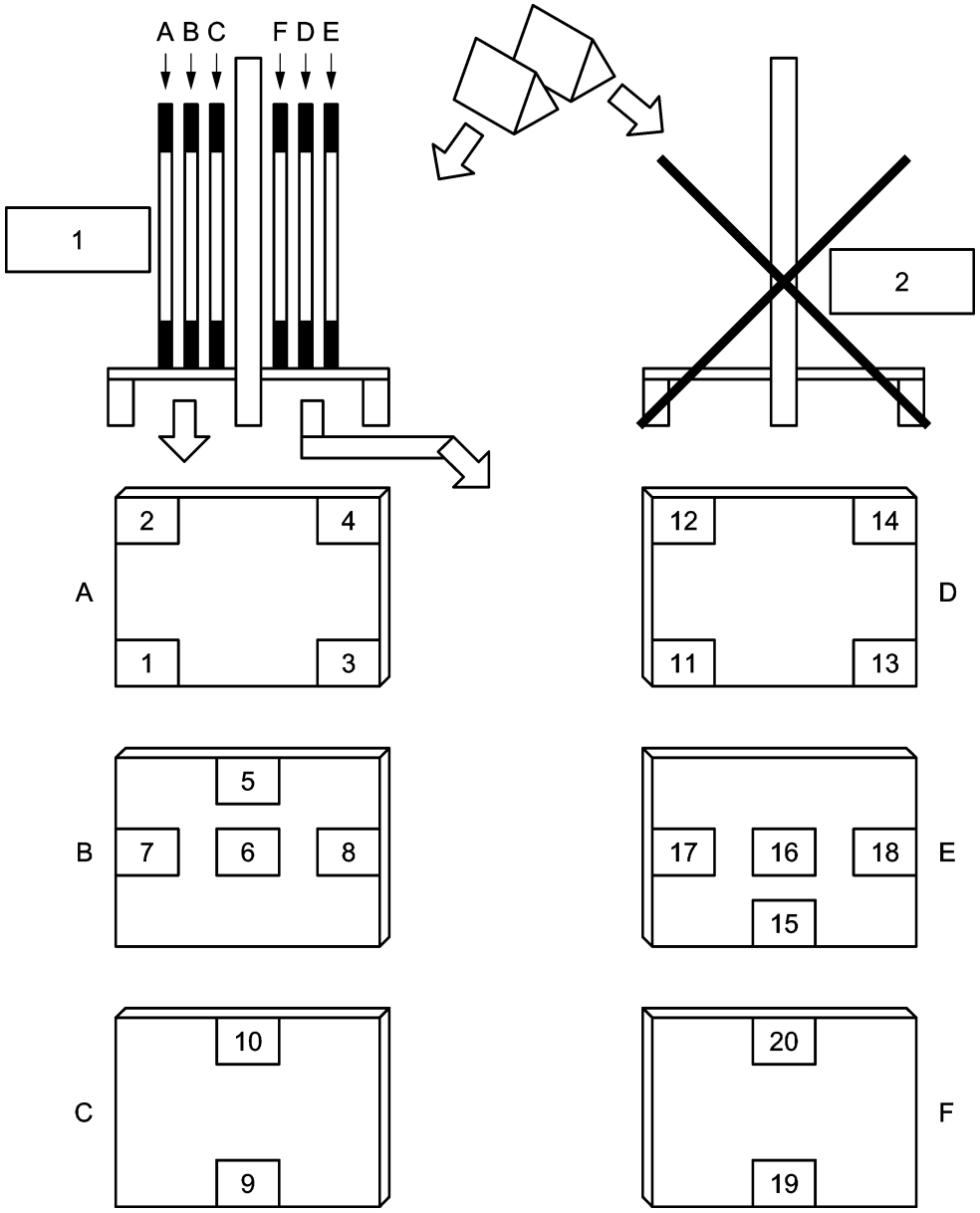
Thermocouples should not be fixed nearer to the edge than 25 mm.

Key

A,B,C glass panes

1,2,3,.. thermocouple positions

Figure A.6 — 2nd category – 2 double sided stillages – full load

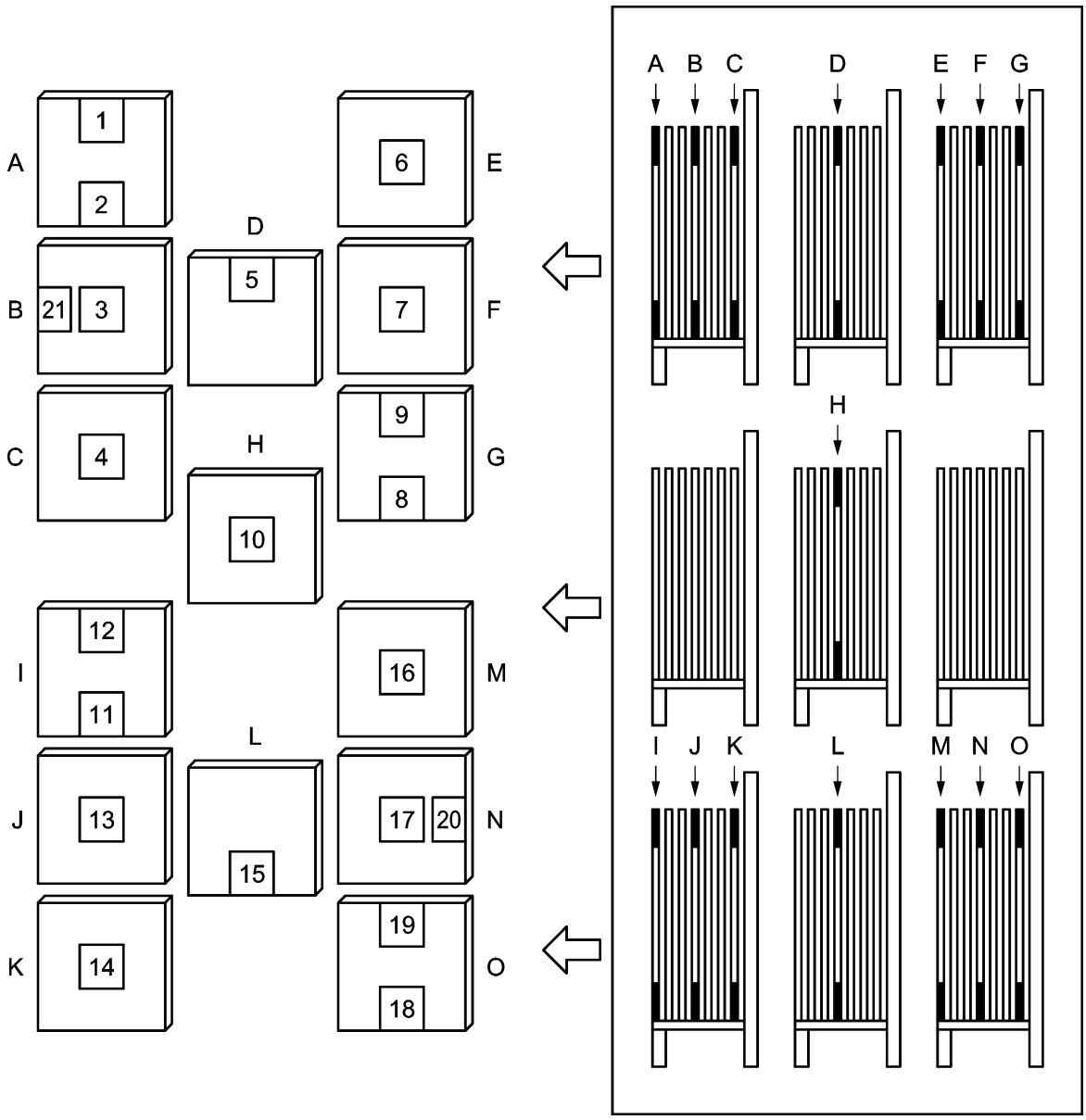


Thermocouples should not be fixed nearer to the edge than 25 mm.

Key

A,B,C	glass panes
1,2,3,..	thermocouple positions
1	1st stillage: minimum 3 glasses in parallel side by side
2	Don't use the 2nd stillage.

Figure A.7 — 2nd category – 2 double sided stillages – 10 % load



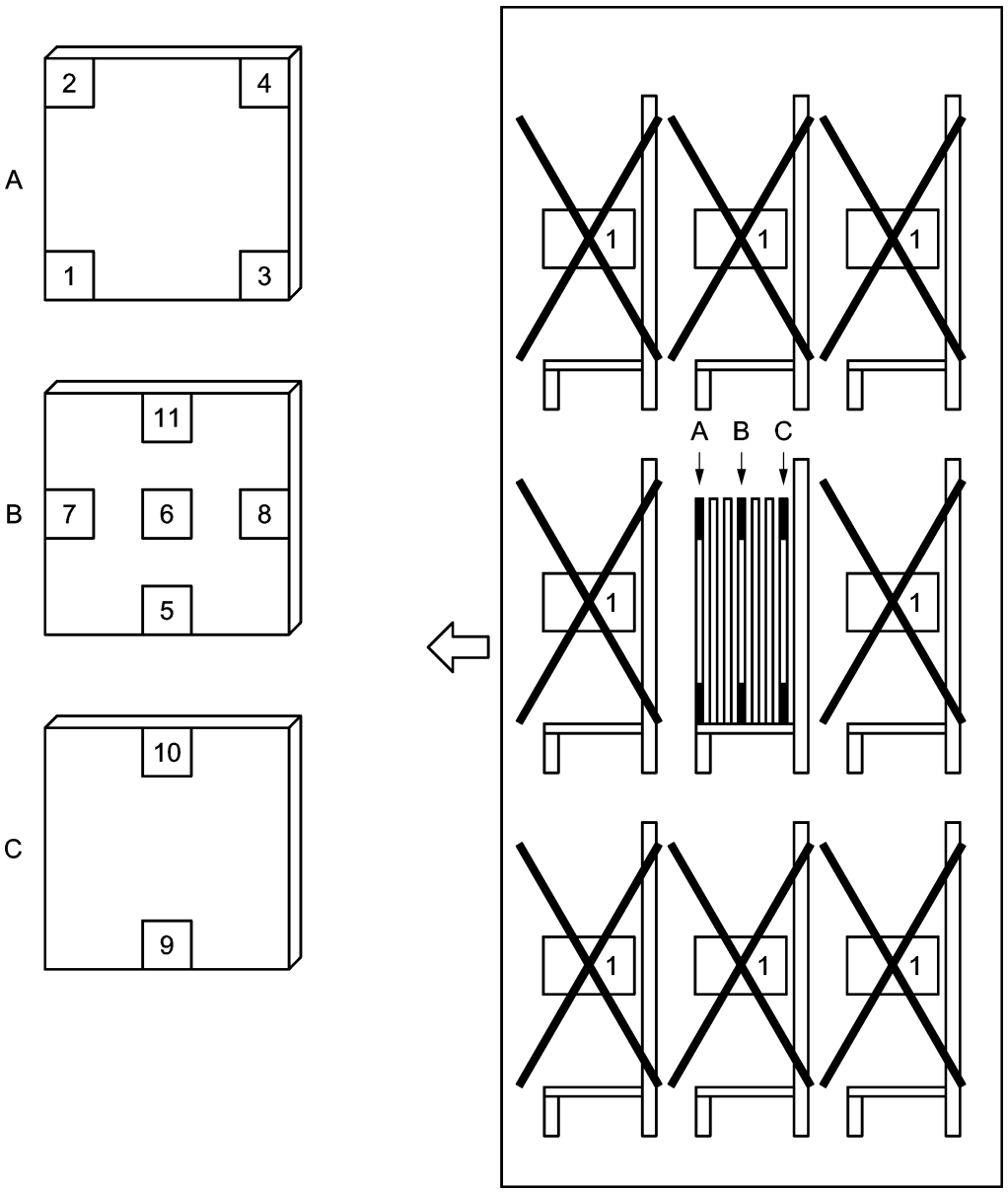
Thermocouples should not be fixed nearer to the edge than 25 mm.

Key

A,B,C glass panes

1,2,3,.. thermocouple positions

Figure A.8 — 3rd category – 6 or 8 or 9 ... stillages – full load



Thermocouples should not be fixed nearer to the edge than 25 mm.

Key

A,B,C	glass panes
1,2,3,..	thermocouple positions
1	Don't use.

Figure A.9 — 3rd category – 6 or 8 or 9 ... stillages – 10 % load

Annex B
(informative)

Curved heat soaked thermally toughened alkaline earth silicate safety glass

Curved (in the UK also called bent) heat soaked thermally toughened alkaline earth silicate safety glass has been deliberately given a specific profile during the course of manufacture. It is not included in this standard since there is insufficient data available to standardise the product.

Annex C
(informative)

Examples of particle count

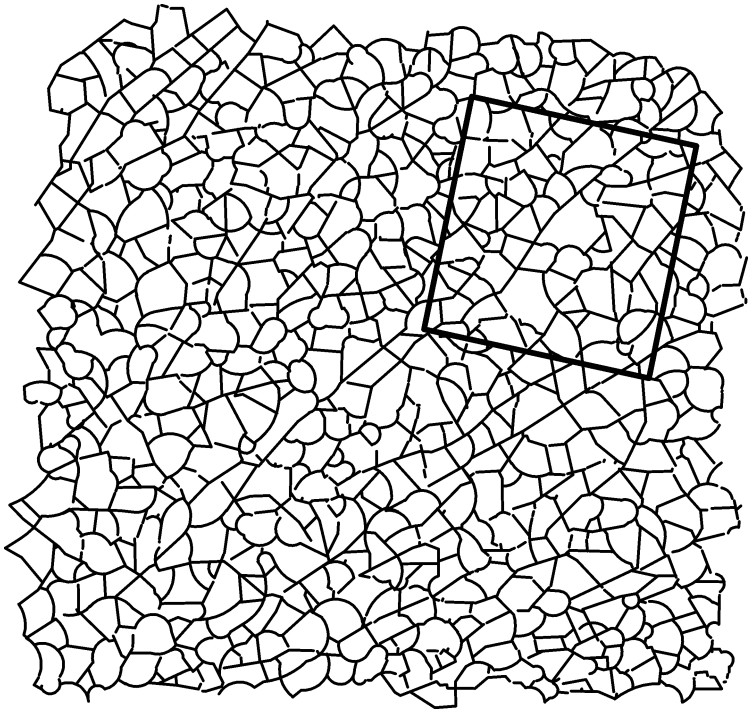
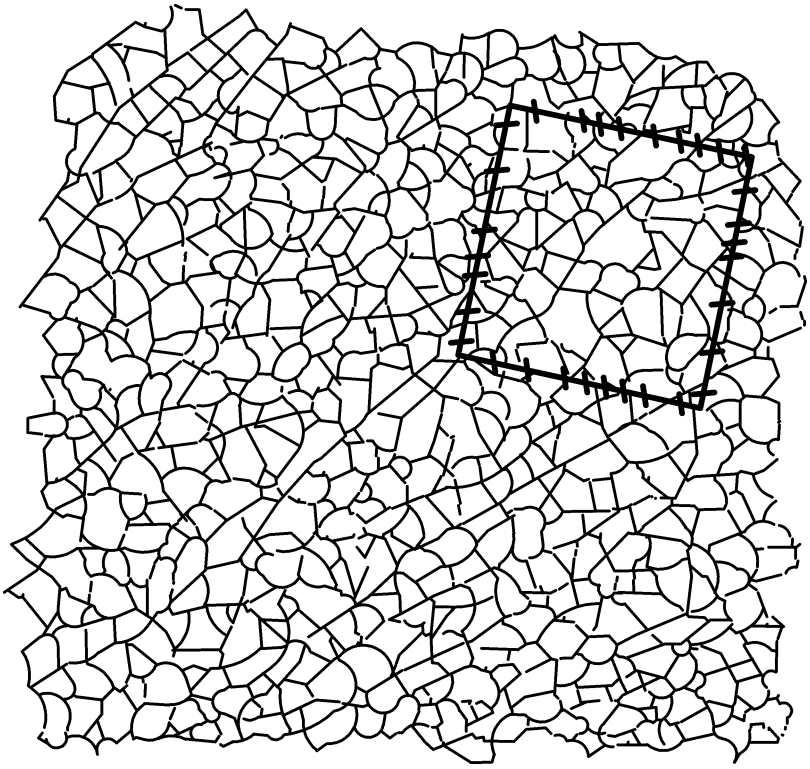


Figure C.1 — Example of selecting the area of coarsest fracture

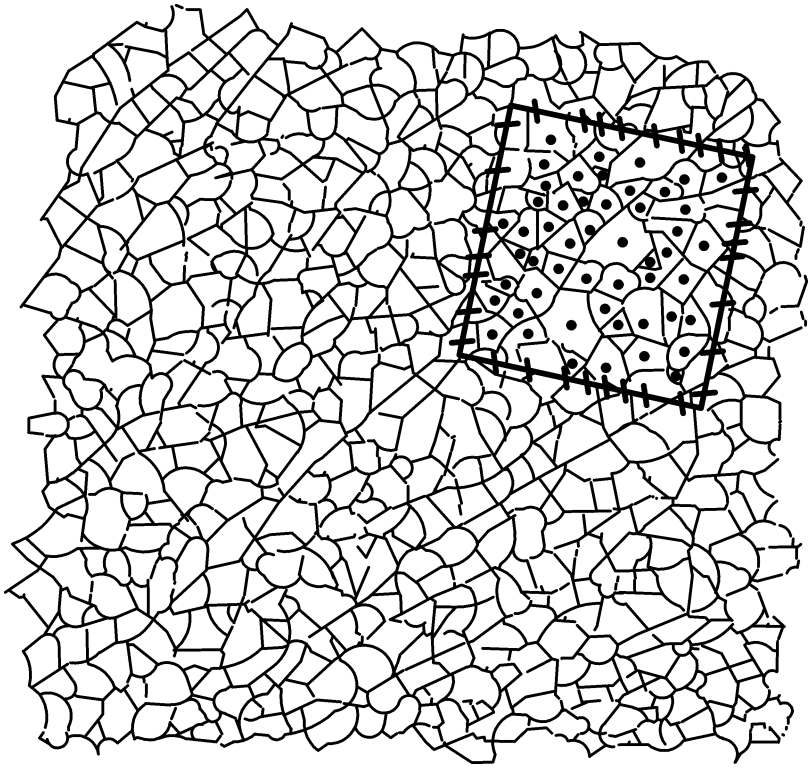
Select the area of coarsest fracture, place the template on the test specimen and draw round the template.



Number of perimeter particles = 32/2 = 16

Figure C.2 — Example of marking and counting the perimeter fragments

Mark and count the perimeter fragments as 1/2 particle each.



Number of central particles = 53

Total number of particles = 16 + 53 = 69

Figure C.3 — Example for marking and counting of overall particle count for the specimen

Mark and count the central fragments and add these to the perimeter count to obtain the particle count for the specimen.

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