Annex F
(normative)

Visual quality of insulating glass units

F.1 General

This annex applies to assessment of the visible quality of insulating glass units made of glass components as defined in 5.2.

The optical and visual quality requirements for glass components shall be taken from the appropriate European Standards.

Tables F.1 to F.3 give the maximum allowable fault per insulating glass unit, as well as the faults that are specific to the assembly. These tables shall not be used for insulating glass unit with at least one component made of patterned glass, wired glass, wired patterned glass, drawn sheet glass, fire resistant laminated glass.

The tables cover insulating glass units of types A, B and C.

F.2 Observation conditions

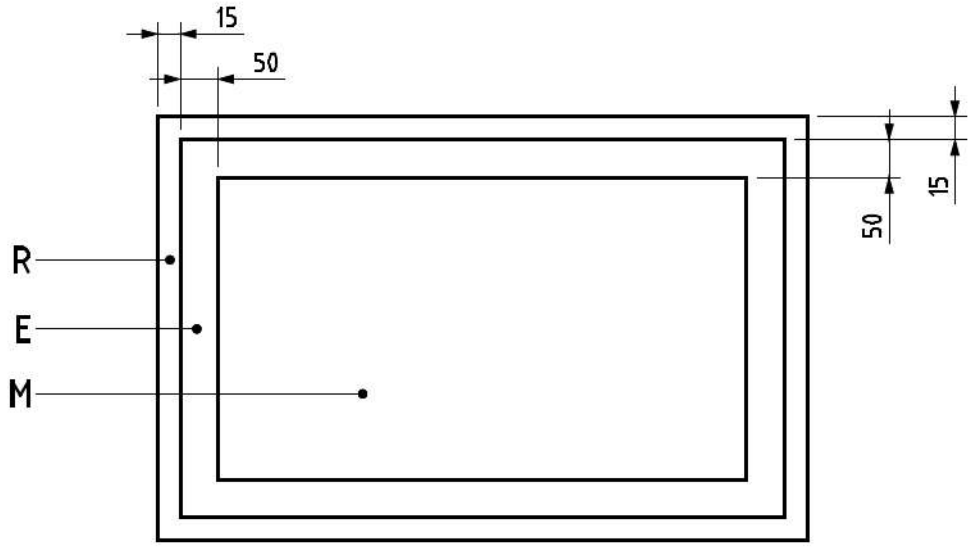
The panes shall be examined in transmission and not in reflection.

The discrepancies shall not be marked on the pane.

The insulating glass units shall be observed at a distance of not less than 3 m from the inside to the outside and at a viewing angle as perpendicular to the glass surface as possible for up to one minute per m^2. The assessment is carried out under diffuse daylight conditions (e.g. overcast sky), without direct sunlight or artificial lighting.

Insulating glass units assessed from the outside shall be examined in installed condition, taking into consideration the usual viewing distance with a minimum of 3 m. The viewing angle shall be as perpendicular to the glass surface as possible.

The following observation zones are defined in Figure F.1.



Key

R zone of 15 mm usually covered by the frame, or corresponding to the edge seal in case of unframed edge

E zone at the edge of the visible area, with a width of 50 mm

M main zone

Figure F.1 — Glass pane defect zones

F.3 Insulating glass unit made of two panes of monolithic glass

F.3.1 Spot faults

The maximum number of spots faults is defined in Table F.1.

Table F.1 — Allowable number of spot faults

Zone	Size of fault (excluding halo) (Ø in mm)	Size of the pane S (m^2)			
		S ≤ 1	1 < S ≤ 2	2 < S ≤ 3	3 < S
R	All sizes	No limitation			
E	Ø ≤ 1	Accepted if less than 3 in each area of Ø ≤ 20 cm			
	1 < Ø ≤ 3	4	1 per metre of perimeter		
	Ø > 3	Not allowed			
M	Ø ≤ 1	Accepted if less than 3 in each area of Ø ≤ 20 cm			
	1 < Ø ≤ 2	2	3	5	5 + 2/m^2
	Ø > 2	Not allowed			

F.3.2 Residues

The maximum allowable number of residue spots and stains is defined in Table F.2.

Table F.2 — Allowable number of residue spots and stains

Zone	Dimensions and type (Ø in mm)	Pane area S (m^2)	
		S ≤ 1	1 < S
R	All	No limitation	
E	Spots Ø ≤ 1	No limitation	
	Spots 1 mm < Ø ≤ 3	4	1 per m of perimeter
	Stain Ø ≤ 17	1	
	Spots Ø > 3 and stain Ø > 17	maximum 1	
M	Spots Ø ≤ 1	Maximum 3 in each area of Ø ≤ 20 cm	
	Spots 1 < Ø ≤ 3	Maximum 2 in each area of Ø ≤ 20 cm	
	Spot Ø > 3 and stain Ø > 17	Not accepted	

F.3.3 Linear / extended fault

The maximum number of linear / extended fault is defined in Table F.3.

Hairlines scratches are allowed provided that they do not form a cluster.

Table F.3 — Allowable number of linear / extended faults

Zone	Individual lengths (mm)	Total of individual lengths (mm)
R	No limitation	
E	≤ 30	≤ 90
M	≤ 15	≤ 45

F.4 Insulating glass units other than made of two monolithic glass panes

The allowable number of discrepancies defined in F.3. is increased by 25 % per additional glass component (in multiple glazing or in a laminated glass component) . The number of allowable defects is always rounded up.

EXAMPLES

— Triple glazed unit made of 3 monolithic glass panes: the number of allowable faults of F.3 is multiplied by 1,25.

— Double glazed unit made of two laminated glass with 2 glass components each: the number of allowable faults of F.3 is multiplied by 1,5.

F.5 Insulating glass unit containing a heat treated glass

The visual quality of thermally toughened safety glass, with or without heat soaking and of heat strengthened glass, when assembled in an insulating glass unit or in a laminated glass which is a component of an insulating glass unit, shall fulfil the requirements of their respective product standard.

In addition to these requirements, for heat treated float glass, the overall bow relative to the total glass edge length may not be greater than 3 mm per 1 000 mm glass edge length. Greater overall bow may occur for square or near square formats (up to 1:1.5) and for single panes with a nominal thickness < 6 mm.

F.6 Edge defects

Allowable edge defects are given in the relevant standard for each glass pane component.

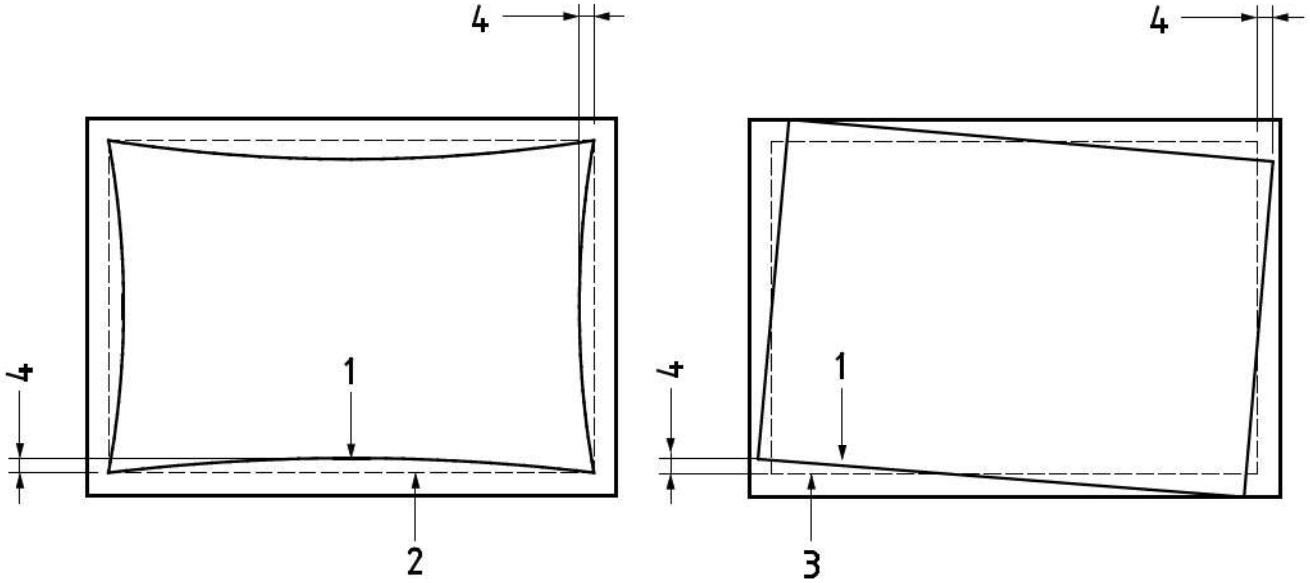
External shallow damage to the edge or conchoidal fractures which do not affect the glass strength and which do not project beyond the width of the edge seal are acceptable.

Internal conchoidal fractures without loose shards, which are filled by the sealant, are acceptable.

F.7 Tolerance on spacer straightness

For double glazing the tolerance on the spacer straightness is 4 mm up to a length of 3,5 m, and 6 mm for longer lengths. The permissible deviation of the spacer(s) in relation to the parallel straight glass edge or to other spacers (e.g. in triple glazing) is 3 mm up to an edge length of 2,5 m. For longer edge lengths, the permissible deviation is 6 mm.

Figure F.2 shows examples of deviation of spacer position.



Key

1 spacer
2 theoretical shape of the spacer
3 theoretical position of the spacer
4 deviation

Figure F.2 — Examples of spacer deviation

F.8 Curved insulating glass units

The visual quality of curved insulating glass units and their glass components shall fulfil the requirements of ISO 11485-1 and ISO 11485-2.

Annex G
(informative)

Other visual aspects of insulating glass units

G.1 General

Some physical effects can occur that are visible on the glass surface and shall not be taken into account when assessing the visual quality. They are not considered as defects.

G.2 Inherent colour

Variations in the colour impression are possible due to the iron oxide content of the glass, the coating process, the coating itself, variation in the glass thickness and the unit construction and cannot be avoided.

G.3 Difference in insulating glass unit colour

Façades made of IGUs incorporating coated glass can present different shades of the same colour, an effect that can be amplified when observed at an angle. Possible causes of differences in colour include slight variations in the colour of the substrate onto which the coating is applied and slight variations in thickness of the coating itself.

An objective assessment of the differences in colour can be done using ISO 11479-2.

G.4 Interference effect

In insulating glass units made of float glass, interference effects may cause spectral colours to appear. Optical interference is due to superposition of two or more light waves at a single point.

The effects are seen as variation in intensity of the coloured zones, which change when pressure is applied to the glass. This physical effect is reinforced by the parallelism of the surfaces of the glass. Interference effects occur at random and cannot be avoided.

G.5 Specific effect due to barometric conditions

An insulating glass unit includes a volume of air or other gas, hermetically sealed by the edge seal. The state of the gas is essentially determined by the altitude, the barometric pressure and the air temperature, at the time and place of manufacture. If the insulating glass unit is installed at another altitude, or when the temperature or barometric pressure changes (higher or lower pressure), the panes will deflect inwards or outwards, resulting in optical distortion.

G.6 Multiple reflections

Multiple reflections can occur in varying intensity at the surfaces of glass units. These reflections can be seen particularly well if the background viewed through the glazing is dark. This effect is a physical property of all insulating glass units.

G.7 Anisotropy (iridescence)

Insulating glass units that contain a heat-treated glass component may show visual phenomena known as anisotropy, see EN 12150-1, EN 1863-1.

G.8 Condensation on the external surface of the insulating glass unit

Condensation can occur on the external glass surfaces when the glass surface is colder than the adjacent air.

The extent of condensation on the external surfaces of a glass pane is determined by the U-value, the air humidity, air movement and the indoor and outdoor temperatures.

When the ambient relative humidity is high and when the surface temperature of the pane falls below the ambient temperature, condensation at the glass surface occurs.

G.9 Wetting of glass surfaces

The appearance of the glass surfaces can differ due to the effect of rollers, finger prints, labels, vacuum suction holders, sealant residues, silicone compounds, smoothing agents, lubricants, environmental influences etc. This can become evident when the glass surfaces are wet by condensation, rain or cleaning water.