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Large Yachts — Windows, portlights — Strength and watertightness requirements

Élément introductif — Élément principal — Partie n: Titre de la partie

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Contents

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The **table of contents** is an optional preliminary element, but is necessary if it makes the document easier to consult. The table of contents shall be entitled “Contents” and shall list clauses and, if appropriate, subclauses with titles, annexes together with their status in parentheses, the bibliography, indexes, figures and tables. The order shall be as follows: clauses and subclauses with titles; annexes (including clauses and subclauses with titles if appropriate); the bibliography; indexes; figures; tables. All the elements listed shall be cited with their full titles. Terms in the “Terms and definitions” clause shall not be listed in the table of contents.

Foreword

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ISO nnn-n was prepared by Technical Committee ISO/TC 000, *TC title*, Subcommittee SC 0, *SC title*.

This second/third/... edition cancels and replaces the first/second/... edition (ISO nnn-n:19xx), [clause(s) / subclause(s) / table(s) / figure(s) / annex(es)] of which [has / have] been technically revised.

ISO nnn consists of the following parts, under the general title *Introductory element — Main element*:

— *Part n: Part title*

— *Part [n+1]: Part title*

— *Part [n+2]: Part title*

The **foreword** shall appear in each document. It shall not contain requirements, recommendations, figures or tables.

It consists of a general part and a specific part. The general part (supplied by the Central Secretariat of ISO) gives information relating to the organization responsible and to International Standards in general, i.e.

a) the designation and name of the committee that prepared the document,

b) information regarding the approval of the document, and

c) information regarding the drafting conventions used, comprising a reference to the ISO/IEC Directives, Part 2.

The specific part (supplied by the committee secretariat) shall give a statement of significant technical changes from any previous edition of the document and as many of the following as are appropriate:

d) an indication of any other international organization that has contributed to the preparation of the document;

e) a statement that the document cancels and replaces other documents in whole or in part;

f) the relationship of the document to other documents.

Large Yachts — Windows, portlights — Strength and watertightness requirements.

1 Scope

This International Standard specifies technical requirements for windows and portlights on Large Yachts, taking into account its design category (short range or unrestricted), and the location of the appliance.

Large Yachts are intended as ships of LOA (Length Over All) over 24 m, in commercial use for sport or pleasure and which carries no cargo and no more than 12 passengers and, in any case, of no more than 3000GT.

This International Standard is intended to be used for Large Pleasure Yachts and for Large Yachts engaged in commercial services (pleasure vessels “engaged in trade” for the purpose of Article 5- Exceptions of ICLL).

The appliances considered in this International Standard are only those that are critical for the ship watertightness, i.e. those that could lead to flooding in case of rupture of the plate.

2 Normative references

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

ISO 6345:1990, Shipbuilding and marine structures – Windows and side scuttles – Vocabulary

ISO 5779:1987, Shipbuilding – Positioning

ISO 3903:1993, Shipbuilding and marine structures – Ships’ ordinary rectangular windows

ISO 1751:1993, Shipbuilding and marine structures – Ships’ side scuttles

ISO 21005:2004, Shipbuilding and marine technology – Thermally toughened safety-glass panes for windows and side scuttles

ISO 614:1989, Shipbuilding and marine structures – Toughened safety glass panes for rectangular windows and side scuttles – Punch method of non-destructive strength testing

ISO 5797:2004, Ships and Marine Technology –Windows and side scuttles for fire-resistant constructions

EN 1288-3:2000, Determination of the bending strength of glass (four points bending test)

EN 12150-1:2000 Thermally Toughened soda lime silicate safety glass – Part 1: Definition and description

ISO 17025:2000, General Requirements for the competence of testing and calibration laboratories

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6345:1990 and the following apply.

3.1
Appliance
Device made of a plate and possibly a framing system, used to cover an opening in the hull or superstructure of a ship.

3.2
Plate
Sheet of material, which may be transparent, that is fixed on the ship structure either directly or via framing system.

3.2.1
Glazing
Transparent or translucent plate.

3.2.2
Unsupported dimensions of a plate
Clear dimensions between the supports bearing the plate.

3.3
Window / Portlight
Glazed appliances, the term portlight is used for small windows.

3.4
Deadlight / Storm Shutter
Secondary watertight closure fitted to a window and which can be fitted inside or outside the plate.

3.5 Flag Administration
The Government of the State whose flag the ship is entitled to fly.

3.6
Design Category
Description of the navigation limitations for which ship is assessed to be suitable.

3.6.1
Design Category: Unrestricted
Ship without GT limitations or operating restrictions.

3.6.2
Design Category: Short Range
Ship under 300 GT restricted to operating in forecast or actual wind of a maximum Beaufort Force 4 and within 90 nautical miles of a safehaven.

3.7
Sail Ship
Ship for which the primary means of propulsion is by wind power.

3.8
Motor Ship
Ship for which the primary means of propulsion is engine power.

3.9
Waterline
Side projection of the floatation plan, when the boat is upright and in fully loaded ready-to-use conditions.

3.10
Length Overall – L_{OA}
length overall - L_{OA} means the distance between the foreside of the foremost fixed permanent structure and the afterside of the aftermost fixed permanent structure; and "fixed permanent structure" includes any portion of the hull which is capable of being detached, but which must be fixed in place during the normal operation of the vessel. It does

not include functional arrangements such as safety rails, bowsprits, pulpits, stemhead fittings, rudders, steering gear, outdrives, outboard motors, propulsion machinery, diving platforms, boarding platforms, rubbing strips and fenders.

3.11
Length - L_{WL}
Length L_{WL} means 96% of the total length on a waterline of a ship at 85% of the least moulded depth measured from the top of the keel, or the length from the fore-side of the stem to the axis of the rudder stock on that waterline, if that be greater. In ships designed with a rake of keel the waterline on which this s measured shall be parallel to the designed waterline.

3.12
Beam - B
Maximum width of the boat at any location along its length.

3.11
Freeboard Deck
Has the meaning given in annex I of ICLL. The freeboard deck is the uppermost complete deck exposed to weather and sea which has permanent means of closing all openings in the weather part thereof, and below which all openings in the side of the ship are fitted with permanent means of watertight closing.

3.11.1
Weather Deck
The uppermost complete weathertight deck fitted as an integral part of the vessel's structure and which is exposed to the sea and weather.

3.11.2
Weathertightness
Weathertight has the meaning given in annex I of ICLL , it means that in any sea conditions water will not penetrate into the ship.

3.12
Watertightness.
Capacity of an appliance to prevent penetration of water into the ship in any direction.

3.13
Strength
Capacity of an appliance to maintain full structural integrity under the action of loads.

3.14
Basic Design Loads
External hydrostatic loads according to which appliance strength and watertightness has to be demonstrated.

3.15
Hull
Part of the ship situated below freeboard deck.

3.16
Superstructure
Superstructure has the meaning given in annex I of ICLL and is normally intended as part of the ship situated above freeboard deck or the weather deck.

3.16.1
Superstructure Order
Superstructure decks are identified by their position starting from the Freeboard deck which is the first superstructure order (1^{st} tier)

3.16.2 Wheelhouse
Control position occupied by the officer of the watch who is responsible for the safe navigation of the vessel.

3.17
Appliance position
Appliance position is defined first by its location above or below freeboard deck, if located below freeboard deck its position is hull position. If appliance is located above the freeboard deck its location is Superstructure – tier order. Finally appliance position will be defined as: Front, Side, Aft / other.

3.18
Plate end connection

3.18.1
Semi-fixed - SF plate
Plate fixed in a way to restrict deflection and prevent lateral movements at its boundaries.
Example: Framed or unframed plate if bolted and/or glued.

3.18.2
Simply Supported – SS plate
Plate that can deflect at his boundaries and/or perform lateral movements
Example: Unframed plate hinged or sliding.

3.19
Glass material

3.19.1
Thermally toughened glass
Glass where strength increase is obtained by the introduction of permanent compression stress, generated by a thermal treatment, on the external side portions of its cross section.

3.19.2
Chemically toughened glass
Glass where strength increase is obtained by the introduction of permanent compression stress, generated by chemical treatment, on the external side portions of its cross section.

3.19.3
Toughened glass with no residual permanent stress
Glass where strength increase is obtained without the introduction of permanent compression stress in any portion of its cross section.

3.19.4
Monolithic glass
Glazing consisting of one ply of glass

3.19.5
Laminated glass
Multi-layer pane made of glass plies, plastic plies or other glazing materials. The plies are kept together by suitable plastic adhesive inter-layers.

3.19.6
Insulating Glazing Units (IGU)
Glazing made of multiples panes either monolithic or laminated separated by sealed gaps filled with gas (air, argon etc.)

3.19.7
Fire resistant Glazing
Glazing made of special material that result in a specific fire resistance. Windows and portlights for fire resistant constructions shall meet the requirements of the FTP code according to SOLAS 74, Chapter ii-2, Regulation 3. The general requirements of such windows are defined in ISO 5797:2004.

3.19.8
Case depth - C_D
When a glass ply is toughened by the introduction of permanent compression stress on the external side portions of its cross section (balanced by tensile stress in a inner cross section portion), case depth - C_D is the depth of the compression stress measured from the external surface to the inner cross section point where compression stress is null.

3.19.9
Surface Compression - S_C
When a glass ply is toughened by the introduction of permanent compression stress on the external side portions of its cross section (balanced by tensile stress in a inner cross section portion), surface compression - S_C is the value of compression stress taken at the external surface.

3.19.10
Modulus of Rupture - M.O.R
Ultimate flexural strength at rupture of a glass sample measured in a flexural test arrangement.

4 Symbols (and abbreviated terms)

A paragraph.

The **Symbols (and abbreviated terms)** clause is an optional element giving a list of the symbols and abbreviated terms necessary for the understanding of the document.

Unless there is a need to list symbols in a specific order to reflect technical criteria, all symbols should be listed in alphabetical order in the following sequence:

— upper case Latin letter followed by lower case Latin letter (A, a, B, b, etc.);

— letters without indices preceding letters with indices, and with letter indices preceding numerical ones (B, b, C, C_m, C_2, c, d, d_{ext}, d_{int}, d_1, etc.);

— Greek letters following Latin letters (Z, z, A, α, B, β, …, Λ, λ, etc.);

— any other special symbols.

For convenience, this element may be combined with the Terms and definitions clause in order to bring together terms and their definitions, symbols, abbreviated terms and perhaps units under an appropriate composite title, for example “Terms, definitions, symbols, units and abbreviated terms”.

5 General Requirements

5.1 General

Other International standards, e.g. dealing with stability and buoyancy, may have restrictions on the position of appliances which are outside the scope of this international Standard and which are therefore not treated here. It is however necessary for the builder or user to ensure that the appliances comply with other relevant International Standards.

5.2 Strength

The strength of windows and portholes shall meet the requirement of this International Standard and of the relevant International Standard cited in the normative references clause when their type is covered. For the scope of this standard strength is considered only with reference to external hydrostatic loads coming from weather and sea conditions. Strength requirement is fulfilled according to the following criteria:

- In case the window type is covered by an existing ISO standard (See 2. Normative References)
- According to the calculation method outlined in clause 8
- According the hydrostatic test procedure outlined in Annex A

External hydrostatic loads (Basic Design Loads) will be the only loads considered for strength requirement fulfilment.

5.3 Watertightness

To avoid flooding, all appliances shall be designed and fixed to prevent substantial ingress of water in the ship. The watertightness requirement is fulfilled according to the following criteria:

- In case the window type is covered by an existing ISO standard (See 2. Normative References)
- According to the clause 7.2 (Fastening requirements)
- According the hydrostatic test procedure outlined in Annex A

6 Plate materials

6.1 General

Appliances plates shall be made of:

- transparent glazing materials, such as toughened glass (Thermally-TT or Chemically CT), polycarbonate (PC) or poly(metyl)metacrilate (PMMA).

- any other material of strength and stiffness equivalent to those cited above.

6.2 Glass

6.2.1 Restrictions of usage

Only toughened glass is allowed as plate material or as plies material for laminated constructions. In wheelhouse glazing, for both front and sides positions, in case of glazing breakage, the pane shall remain in its position and watertightness and residual vision are to be maintained. In wheelhouse glazing, for both front and side positions, IGU glazing are not allowed because of possible optical distorsion. For monolithic construction only toughened glass meeting the requirements of the fragmentation test outlined in EN 12150:2000 Clause 8 shall be used.

6.2.2 Chemically Toughened Glass

As chemically toughened glass is not covered by existing ISO standards the following characteristics have to be declared by the glass ply manufacturer:

- Depth of compression layer - C_D (µm)

- Surface Compression - S_C (N/mm^2) or Ultimate Flexural Strength/Modulus of Rupture – MOR (N/mm^2)

The glass ply manufacturer is also responsible of the production conformity to the declared values. Acceptable values to comply with this International Standard are at minimum:

- $C_D \geq 25$ µm

- $S_C \geq 170$ N/mm^2 or MOR ≥ 220 N/mm^2

7 Specific requirements

7.1 End connection and location of appliance

7.1.1 Simply supported connected plates

Simply supported plates shall not be used in Hull or Superstructure positions where they may come in contact with hydrostatic loads. On other positions simply supported plates may be used providing that the following condition is met:

- The fixing device of the plate (hinge bolts, fixing knob, etc) are not spaced more than 250 mm

7.1.2 Glass Plates

Direct metal to glass contact shall always to be avoided.

7.2 Fastening Requirements

7.2.1 Fastening of plates and frames

Plates and frames can be fastened by mechanical means, glue or elastomeric joints. All types of fastening shall ensure watertightness of the plate to the frame and resistance to loads due to normal operating pressure.

Every part of the mechanical elements connecting appliances to the rest of the ship shall be capable of withstanding , without breakages, twice the force F (kN) induced by the pressure loads defined in clause 8.

$$F = 2 \cdot a \cdot b \cdot P_D$$

where a and b are the unsupported dimensions of the appliance (or its equivalents as defined in Annex C) expressed in meters, and P_D (kPa) is the basic design load defined in clause 8. This analysis can be performed by calculation or by test and has to be extended to all the mechanical elements including hinges, locks, supporting frames and gluing joints.

7.2.2 Fastening of glued plates

Glued joints shall be resistant to (or protected against) sunlight (UV-Ultraviolet radiation, heat) and all the environmental effects or cleaning chemicals encountered in the manufacturing and use of the ship. The manufacturer's gluing procedure and conditions must always be declared and followed and the bond strength checked by calculation to meet pressure loads as defined in clause 8. The gluing operators shall be qualified and authorized by the glue manufacturer. Glued joints shall fulfil the requirements of one of the following items:

a) The inside pressure test
b) The separation test

The above requirements shall be verified after any change in material or gluing procedure.
Plates, with or without framing are considered glued if they are fastened with mechanical devices, such as bolts, rivets or screws, spaced more than 20 times the nominal plate thickness defined in clause 8.

7.3 Special Requirements

7.3.1 Appliances fitted in hull

7.3.1.1 Height above waterline

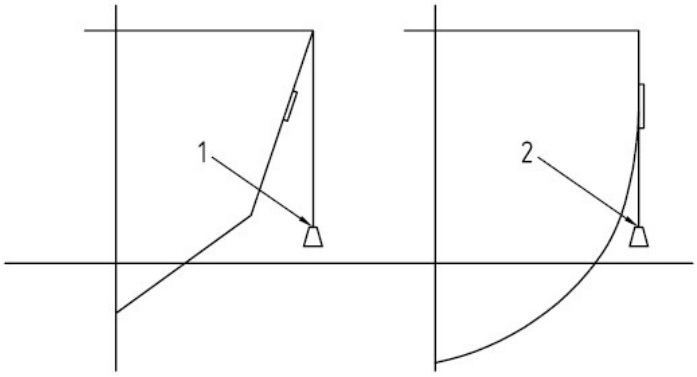
The lower edge of any opening appliance shall be placed at least 500 mm above the waterline or 2,5 % of maximum beam – B whichever is greater, the ship being in the fully loaded ready-for-use condition and upright. Limitations in maximum area of appliances are left to flag administration requirements.

7.3.1.2 Opening side

Any opening appliance shall open inwards.

7.3.1.3 Protection

No part of the plate or its framing shall extend outside the local vertical tangent to the hull, deck, rubbing strake, fixed tender, or of a built in fairing which is an integral part of the hull. Figure 1 explains this requirement.



Key

1 The local vertical tangent is outside the porthole: no problem

2 The local vertical tangent is inside the porthole: the porthole shall either be placed in a recess or protected by a built-in fairing

Figure 1 – Sketch explaining clause 7.3.1.2

7.3.1 Deadlights and Stormshutters

7.3.2.1 Appliances located below the freeboard deck or weather deck

Deadlights are requested for any appliance located in the Hull below the freeboard deck.

7.3.2.2 Appliances located above the freeboard deck or weather deck

Stormshutters are normally requested for Unrestricted design category appliances located in front and side positions on 1st Superstructure tier and in front position on 2nd Superstructure tier. Stormshutters are not requested on Superstructure for Short range design category.

Stormshutters may be avoided on 1st and 2nd Superstructure tier for Unrestricted design category if one of the following conditions applies:

- The plate is of laminated construction and its equivalent plate thickness is 1.3 times higher than the one calculated in clause 8. In that case only a blanking plate is requested.
- The plate is of laminated construction and in the plate construction there is an additional 3 mm ply of polycarbonate extended to the support of the plate
- The hydrostatic load test is passed at 4 times the relevant design load without breakages and the broken window (at least one ply broken) withstand the design load pressure maintaining full watertightness.

8. Scantling determination of plates

8.1 Basic plate thickness determination

The formula given in 8.1.1 is valid for rectangular plates. For circular plates, replace b by d, which is the unsupported diameter.

For plates having unsupported shapes different from a rectangle or a circle, the approximations of annex C shall be used to determine the “equivalent” unsupported dimensions.

8.1.1 Basic thickness -t_O

$$t_O = b \cdot \sqrt{\frac{\beta \cdot P_D}{\sigma_A}}$$

where:

t_O (mm) – is the basic plate thickness

b (mm) – is the unsupported short side of a rectangular plate or “equivalent short side” of a plate

β - is the plate-aspect ratio coefficient (see 8.3)

P_D (Pa) – is the basic design pressure

σ_A (Pa) – is the allowable flexural stress of the material

8.2 Plate aspect ratio coefficient - β

The plate aspect ratio coefficient, β shall be taken from Figure 2 (taken from ISO 21005:2004) for rectangular plates and from table 1 for circular plates. The β coefficient is a function of the aspect ratio AR= a/b which is the ratio of the unsupported dimensions where a and b are respectively the long and short unsupported dimensions (or their equivalent dimensions determined according to annex C) of a rectangular plate expressed in millimetres.

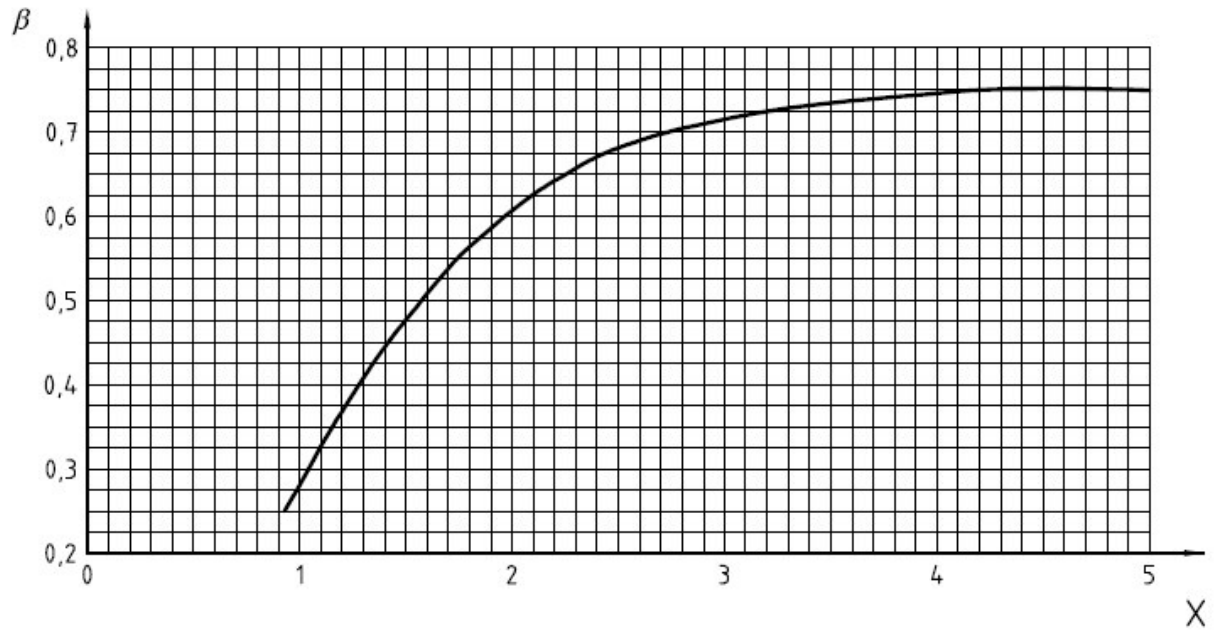


Figure 2 – Plate aspect ratio coefficient - β (X=AR)

Table 1 - Value of β for Circular plates

Values of β for Circular plates	0,25

8.3 Basic design pressure

The basic design pressure for calculation of the plate thickness shall be selected from Table 2

Table 2- Basic Design Pressure - P_D (kPa)

Service Type	Navigation restrictions	HULL	SUPERSTRUCTURE		
			1st tier Front	2nd tier Front	Fronts above 2nd tier and all Sides and Aft
Commercial Service	Short Range	120	35	15	10
	Unrestricted	120	$45+L_{WL}/10$	35	15
Pleasure		70	15	10	10

8.4 Ultimate Flexural Strength - MOR

The values of ultimate flexural strength of the plate material are the manufacturer's stated values. Values should be given for glass when tested according to EN 1288-3:2000. Means values are acceptable if test has been performed at least on 30 samples, if test has been performed on less than 30 samples the accepted value is the one corresponding to the lower confidence interval value evaluated by the T-student distribution at 95% probability.In the absence of such data the typical values given in table 3 may be used.

8.5 Design factor, allowable flexural strength and minimum plate thickness

The allowable flexural stress of the material σ_A is determined from:

$$\sigma_A = \frac{\sigma_{UFS}}{\gamma}$$

where γ is the design factor given in table 4.

Table 3 - Mechanical properties of materials

Material	Acronym	MOR - σ_{UFS} (MPa)	Design Factor -γ	Allowable Strength σ_A (MPa)
Poly(methyl)methacrilate	PMMA	110	3,5	31,4
Policarbonate	PC	90	3,5	25,7
Thermally toughened Glass	TT	160	4,0	40,0
Chemically toughened Glass	CT	220	4,0	55,0

8.6 Selection of monolithic plate thickness

The value of the actual plate thickness t_a, expressed in millimetres, to be used in case of monolithic construction, shall be the greatest of the following:

- the basic plate thickness, t_O calculated in 8.1.1

- the minimum plate thickness, t_m according to the relevant ISO Standard (ISO 3903:1993 , ISO 21005:2004) when applicable, in any case should be always $t_m \geq 8$ mm.

With commercially available plates, the nominal commercial thickness will be selected as the first upper integer above the calculated basic thickness.

8.7 Laminated glass thickness

In order to calculate the thickness of a laminated glass construction made of n plies of thicknesses: $t_1,t_2,...,t_n$, the equivalent thickness of laminated construction is calculated and compared with the basic thickness calculated according to clause 8.1.1 as :

a) if the difference in thickness between any of two glass plies is less than or equal to 2 mm when plies are up to 12 mm and less or equal to 4 mm when glass plies are up to 19 mm and the thickness of the plastic interlayer is less than or equal to 2 mm, than:

$$t_{eq} = \sqrt{(t_1^2 + t_2^2 + ... + t_n^2)}$$

and

$t_{eq} \geq t_O$

b) If the conditions of a) above are not met, each ply shall be considered as stressed according to its section modulus and shall be analyzed according to clause 8.

c) Polycarbonate, Poly(metyl)metacrilate plies or any plastic foil or ply in construction with glass plies are not considered providing that their thickness is less or equal to 3 mm and the correspondent interlayer is less or equal to 2 mm. If their thickness exceed 3mm they are considered to decouple the laminates construction and the two parts of the construction have to considered as independent.

Note: If the PC, PMMA and plastic foil or ply is the outer ply of a construction, its influence is negligeable regardless of their thickness.

8.8 IGU panes thickness determination

The outer pane of the IGU is to be calculated according to 8.6 if monolithic or 8.7 if laminated using the relevant design pressure loads from table 3. The inner pane will be calculated again a according to 8.6 if monolithic or 8.7 if laminated using the relevant design pressure loads from table 3 reduced by a load sharing coefficient that will be at minimum 0.3.

8.9 Fire resistant Glazing

The strength requirement for fire resistant glazing will be fulfilled if the construction will be evaluated according to ISO 5797:2004