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**Large yachts — Strength,  
weathertightness and watertightness of  
glazed openings —**

Part 1:

**Design criteria, materials, framing and  
testing of independent glazed openings**

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*Grands yachts — Résistance, imperméabilité au mauvais temps et  
étanchéité des ouvertures vitrées —*

ISO 11336-1:2012

*Partie 1: Critères de conception, matériaux, armature et essais des  
ouvertures vitrées indépendantes*

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 11336-1 was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 12, *Ships and marine technology — Large yachts*.

ISO 11336 consists of the following parts, under the general title *Large yachts — Strength, weathertightness and watertightness of glazed openings*:

- *Part 1: Design criteria, materials, framing and testing of independent glazed openings*
- *Part 2: Glazed opening integrated into adjacent structure (directly bonded to the bulkhead or shell), design criteria, structural support, installation and testing*
- *Part 3: Quality assurance, installation and in-service inspection*

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# Large yachts — Strength, weathertightness and watertightness of glazed openings —

## Part 1: Design criteria, materials, framing and testing of independent glazed openings

### 1 Scope

This part of ISO 11336 specifies technical requirements for independent glazed openings on large yachts, taking into account navigation conditions, and the location of the opening.

Large yachts are yachts with length of the hull,  $L_H$ , higher or equal to 24 m, in use for sport or pleasure and commercial operations, with a tonnage limitation up to 3 000 gross tonnage, according to the International Tonnage Convention.

The opening and the associated closing appliances considered in this part of ISO 11336 are only those that are above the deepest waterline (dsw) and are critical for the ship integrity related to weathertightness and watertightness, i.e. those that could lead to ingress of water in the hull in case of rupture of the pane.

The scope of this part of ISO 11336 is related to and limited to independent glazed openings.

**NOTE** This part of ISO 11336 is based on the experience of ship window and glass manufacturers, shipbuilders and authorities who apply to ships the regulations of SOLAS, as amended, and of the International Convention of Load Lines, as amended, noting the provisions by the SOLAS Protocol of 1988, Article 8, as agreed by the appropriate Marine Administration.

### 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 178, *Plastics — Determination of flexural properties*

ISO 1751, *Shipbuilding and marine structures — Ships' side scuttles*

ISO 3903, *Shipbuilding and marine structures — Ships' ordinary rectangular windows*

ISO 5797, *Ships and marine technology — Windows and side scuttles for fire-resistant constructions*

ISO 6345, *Shipbuilding and marine structures — Windows and side scuttles — Vocabulary*

ISO 8666, *Small craft — Principal data*

ISO 12543-1, *Glass in building — Laminated glass and laminated safety glass — Part 1: Definitions and description of component parts*

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

ISO 21005, *Shipbuilding and marine technology — Thermally toughened safety-glass panes for windows and side scuttles*

EN 1288-3, *Glass in building — Determination of the bending strength of glass — Part 3: Test with specimen supported at two points (four point bending)*

EN 1990:2008, *Eurocode — Basis of structural design*

EN 12150-1:2000, *Glass in building — Thermally toughened soda lime silicate safety glass — Part 1: Definition and description*

EN 12337-1, *Glass in building — Chemically toughened soda lime silicate safety glass — Part 1: Definition and description*

EN 13195-1, *Aluminium and aluminium alloys. Specifications for wrought and cast products for marine applications (shipbuilding, marine and offshore)*

### 3 Terms and definitions

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

#### 3.1

##### **glazed opening**

opening in the hull, superstructure or deckhouse of a ship structure to be fitted with a transparent or translucent material

#### 3.2

##### **independent glazed opening**

glazed opening where the mechanical behaviour of the pane can be considered independent from adjacent structure, e.g. framed appliance

#### 3.3

##### **glazed opening integrated into adjacent structure**

glazed opening where the mechanical behaviour of the pane cannot be considered independent from adjacent structure, e.g. pane bonded directly into a seat

#### 3.4

##### **appliance**

device made of a pane and a fixing system, used to cover an opening in the hull, superstructure or deckhouse

#### 3.5

##### **pane**

sheet of material fixed within or to a frame

#### 3.6

##### **glazing**

transparent or translucent pane

#### 3.7

##### **unsupported dimensions of a pane**

clear dimensions between the supports bearing the pane

NOTE See Annex A.

#### 3.8

##### **deadlight**

secondary watertight closure fitted to a glazed opening and which is fitted on the inside of the vessel

#### 3.9

##### **storm shutter**

portable protective closure fitted to a glazed opening and which is fitted on the outside (weatherside) of the vessel

#### 3.10

##### **flag administration**

government of the state whose flag the yacht flies

**3.11****certifying authority**

flag administration or the organization to whom the flag administration delegates certifying authority

**3.12****service**

description of the service limitations for which a yacht is assessed to be suitable

**3.13****commercial service**

yachts engaged in commercial use carrying no cargo and generally not more than 12 passengers or not needing to comply with passenger ship requirements

**3.14****pleasure service**

private yachts not engaged in trade

**3.15****operational range and limits**

description of the operation limitation for which a yacht is assessed to be suitable

**3.16****operational conditions: unrestricted range yachts**

extended distance from safe haven where conditions experienced can exceed wind force 8 (Beaufort scale) and significant wave heights of 4 m but limited to 6 m, excluding abnormal conditions

**3.17****operational conditions: intermediate range yacht**

distance of not more than 200 NM from safe haven, with significant wave height > 2 m but not greater than 4 m

**3.18****operational conditions: short range yacht**

distance of not more than 90 NM from safe haven, with significant wave height  $\leq$  2 m

**3.19****freeboard deck**

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 sides of the ship are fitted with permanent means of watertight closing

NOTE At the option of the owner and subject to the approval of the administration, a lower deck can be designated as a freeboard deck, provided it is a complete and permanent deck continuous in a fore and aft direction at least between the machinery space and peak bulkheads and continuous athwart-ships.

**3.20****standard superstructure height**

$h_{std}$

for vessels up to 75 m load line length: height to be taken as 1,8 m; for vessels over 125 m load line length: height to be taken as 2,3 m; for vessels of intermediate lengths: height to be obtained by linear interpolation

**3.21****load line length**

$L$

96 % of the total length on a waterline at 85 % of the least moulded depth measured from the top of the keel, or as the length from the fore side of the stem to the axis of the rudder stock on that waterline, if that be greater

NOTE For ships without a rudder stock, the length,  $L$ , is taken as 96 % of the waterline at 85 % of the least moulded depth.

**3.22  
limits in glazed openings**

maximum size of glazed openings specified in this part of ISO 11336 below a line 0,05 times ship length or forward of a line drawn at the intersection of the 0,05  $L$  waterline and the stem and below a line drawn at  $0,05 L + h_{std}$ , not exceeding 0,85 m<sup>2</sup>

NOTE See Figure 1.

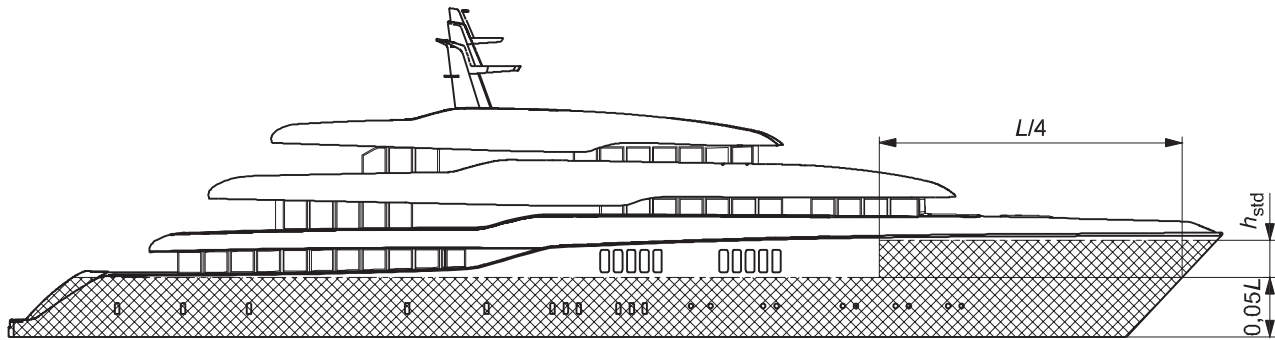


Figure 1 — Area in which glazed openings are limited to 0,85 m<sup>2</sup>

**3.23  
large yacht**

yachts in use for sport or pleasure and commercial operations of  $L_H$  higher or equal to 24 m, which is measured according to ISO 8666

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**3.24  
weathertightness**

capacity to prevent that, in any sea conditions, water will penetrate into the ship

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NOTE Meaning of weathertight taken from Annex I, Regulation 3 (12) of International Convention of Load Lines (ICLL). This is interpreted generally as indicating that weathertightness is required from the exterior only, as opposed to watertightness indicating the ability to withstand from both inside and outside (see 3.27).

**3.25  
watertightness**

capacity of an appliance to prevent the passage of water through the structure in any direction under a head of water for which the surrounding structure is designed

**3.26  
strength**

capacity of a structure to maintain full structural integrity under the action of loads

**3.27  
design loads**

external hydrostatic loads according to which glazed openings strength is assessed

**3.28  
hull**

part of the yacht within the envelope of the side shell and decks taken into account for the assignment of freeboard and for stability evaluation

**3.29  
superstructure**

decked structure on the freeboard deck, extending from side to side of the yacht or with side plating not being inboard of the shell plating more than 4 % of the yacht breadth

NOTE Definition adapted from Annex I, Regulation 3 (10) of International Convention of Load Lines (ICLL).



**3.30****deckhouse**

structure enclosing a space that is normally accessible and used for accommodation or service and that does not qualify as a superstructure and that can be positioned on the freeboard deck, and/or the tiers above

**3.31****wheelhouse**

control position occupied by the officer of the watch

**3.32****glass and plastic materials**

materials used for glazed openings, as specified in 3.35 to 3.45, and 3.49 and 3.50, with a *characteristic failure strength* (3.46)

**3.33****glass ply**

plate made of an inorganic non-crystalline solid exhibiting a glass transition behaviour

**3.34****thermally toughened glass**

glass where strength increase is obtained by a thermal treatment resulting in the introduction of permanent compression stress on both sides of its cross section

**3.35****chemically toughened glass**

glass where strength increase is obtained by chemical treatment resulting in the introduction of permanent compression stress on both sides of its cross section

**3.36****monolithic glass**

glazing consisting of one ply of glass [ISO 11336-1:2012](#)

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**3.37****laminated glass**

multi-layer pane made of glass plies, plastic plies or other glazing materials, which are kept together by suitable plastic adhesive films or curable resins

**3.38****safety glass**

monolithic thermally toughened glass, fully tempered, or laminated thermally or chemically toughened glass

**3.39****insulating glazing units****IGU**

glazing made of multiple panes, either monolithic or laminated, separated by sealed gaps filled with gas (air, argon, etc.)

**3.40****glass case depth**

$l_{CD}$

when a glass ply is toughened by the introduction of permanent compression stress on both sides of its cross section, depth of the compression stress layer measured from the surface to the inner cross section point where compression stress is zero

**3.41****glass surface compression**

$S_C$

when a glass ply is toughened by the introduction of permanent compression stress on both sides of its cross section, value of compression stress taken at the surface

**3.42**

**plastic ply**

rigid plastic plate where “rigid” means that the plastic material has a modulus of elasticity in flexure or, if not applicable, then in tension, greater than 700 MPa

**3.43**

**interlayer**

laminating adhesive material that holds together the plies of a laminated glazing

NOTE It can be a thermo plastic adhesive film or a curable resin.

**3.44**

**characteristic failure strength**

$\sigma_c$

ultimate flexural strength of *glass pane* (3.47) or *plastic material* (3.48)

**3.45**

**glass pane**

ultimate flexural strength at rupture of glass measured, on a statistical basis, in a flexural testing arrangement with a defined method of data reduction taking in account statistical dispersion

**3.46**

**plastic material**

ultimate flexural strength at rupture or flexural strength at yield, whichever is lower

NOTE The choice between the value at rupture or at yield depends on the mechanical characteristics of the plastic material; as a general indication brittle plastic material will break before yielding while non-brittle plastic material will yield before breaking.

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**3.47**

**main structural section**

monolithic or laminated pane construction that meets the strength requirements according to 5.2

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**3.48**

**additional functional plies**

additional glass or plastic plies or panes not included in the frame that can be coupled to the main structural section and that do not have structural functionalities and do not affect structural functionality of the main structural section

NOTE The flexural modulus/flexural strength,  $E/\sigma_c$ , is substantially less (50 %) than that of the main structural section.

**3.49**

**deepest seagoing waterline**

**dsw**

either the assigned waterline for commercial yachts or the deepest seagoing waterline for private yachts

**3.50**

**forward perpendicular**

perpendicular taken at the forward end of the length,  $L$ , and which coincides with the foreside of the stem on the waterline on which the length is measured

**4 Symbols and abbreviated terms**

$p_D$	design pressure
$a$	factor relating to location and vessel length
$b$	factor based on longitudinal location
$f$	factor based on vessel length

$c$	factor based on width of superstructure or deckhouse
$h$	height of centre of pane from dsw
$h_{\text{std}}$	standard superstructure height
$k_{\text{S}}$	service factor
$L_{\text{H}}$	length of the hull
$L$	load line length
$L_{\text{p}}$	length between perpendiculars on summer load waterline
$x$	distance of centre of pane or storm shutter from aft perpendicular
$t_{\text{O}}$	basic pane thickness
$a_{\text{P}}$	unsupported long side of a rectangular pane or “equivalent long side” of a pane
$b_{\text{P}}$	unsupported short side of a rectangular pane or “equivalent short side” of a pane
$\beta_{\text{S}}$	pane aspect-ratio coefficient for stress
$\beta_{\text{D}}$	pane aspect-ratio coefficient for deflection
$\sigma_{\text{A}}$	allowable design flexural stress of the material
$d$	diameter of a circular glazed opening
$\sigma_{\text{C}}$	characteristic breaking strength of a material or laminate
$\gamma$	design factor
$t_{\text{a}}$	actual pane thickness
$t_{\text{min}}$	minimum pane thickness
$t_{\text{p1}}, t_{\text{p2}}, \dots, t_{\text{pn}}$	ply thicknesses of a laminated pane
$t_{\text{eq},j}$	equivalent thickness of each ply of the laminate
$t_{\text{eq}}$	equivalent thickness of laminated construction
$t_{\text{L}}$	physical thickness of a laminate
$\delta_{\text{max}}$	maximum pane deflection
$M$	pane stiffness
$l_{\text{CD}}$	depth of compression layer
$S_{\text{C}}$	surface compression
$N$	number of test specimens
$n$	number of independent plies
$\sigma_i$	breaking stress for each test specimen when tested according to EN 1288-3 for glass or ISO 178 for brittle plastic materials; stress at yield for each test specimen when tested according to ISO 178 for non-brittle plastic materials
$\sigma_{\text{av}}$	average breaking stress or yield stress, whichever is applicable
$s_x$	standard deviation

$C_V$	coefficient of variation
$K_n$	statistic coefficient corresponding to 95 % confidence limit
kN	kilonewtons
$E$	Young's modulus
$\nu$	Poisson's ratio
$SM$	Section Modulus
NM	nautical miles
ICLL 1966	International Convention on Load Line 1966, as amended
IACS	International Association of Class Societies
TTG	Thermally Toughened Safety Glass
CTG	Chemically Toughened Glass
IGU	Insulated Glass Units
MSS	Main Structural Section
PMMA	PolyMethylMethAcrylate
PC	Polycarbonate
dsw	deepest seagoing waterline
FRP	Fibre Reinforced Plastics

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## 5 Design criteria

### 5.1 General

Other International Standards, e.g. dealing with stability, buoyancy, weathertight or watertight integrity, may have restrictions on the position of appliances which are outside the scope of this part of ISO 11336 and which are therefore not considered here. However it is necessary for the builder or user to ensure that the appliances comply with other relevant International Standards.

It is also possible that national authorities can have additional requirements differing from those of this part of ISO 11336. It is necessary that individual statutory regulations of flag administrations for commercial yachts be observed. For example, where yachts are complying with the published "Conditions of Assignment" of the International Convention on Load Line, 1966, as amended<sup>[6]</sup>, the maximum size of a glazed opening below the freeboard deck is 0,16 m<sup>2</sup>.

### 5.2 Strength

The strength of glazed openings and associated appliances shall meet the requirements of this part of ISO 11336 and of the applicable International Standard cited in Clause 2, which covers their type. For the scope of this part of ISO 11336, strength is considered only with reference to local loads, that is, external hydrostatic loads coming from weather and sea conditions. Strength requirements are fulfilled according to any of the following criteria:

- where the glazed opening type is covered by an existing relevant International Standard, such as ISO 3903 or ISO 1751, respectively;
- where the pane thickness is calculated according to the method outlined in 5.6, and the glass is flat or convex towards the load action direction and strength requirements of the frame are according to an existing relevant International Standard;

- when the pane has been tested according to the hydrostatic test procedure outlined in 7.3.

External hydrostatic loads (design loads) shall be the only loads considered for strength requirement fulfilment according to this part of ISO 11336. For a particular application, other requirements and criteria can be relevant and may apply.

Strength requirements for monolithic and laminated constructions shall be fulfilled only for the main structural section. Additional functional plies or panes are, normally, not intended to fulfil strength requirements or to take part in the structural validation of the appliance in the hydrostatic test outlined in 7.3. Such plies or panes shall not adversely affect the strength of the main structural section.

According to qualification by hydrostatic test, any changes to the glazing materials or any change to the cross section or larger dimensions of the glazing shall require re-testing. For tolerances, see 7.3.2.

### 5.3 Watertightness

The appliance shall be designed and mounted to prevent ingress of water into the yacht according to any of the following criteria:

- where the appliance type is covered by an existing relevant International Standard;
- where the pane thickness is calculated according to the method outlined in 5.6 and the pane is clamped with rubber gasket (bonding may be used alternatively) or bonded in the frame with the bonding joint in compression and the strength requirements of the frame are according to an existing relevant International Standard;
- when tested according to the hydrostatic test procedure outlined in 7.3.

Any changes to the glazing materials or any change to the cross section or larger dimensions of the glazing shall require re-testing. For tolerances, see 7.3.2.

### 5.4 Weathertightness

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The weathertightness requirements shall be fulfilled by performing a hose test in the final installation on board. The hose test consists of hosing the appliance along its perimeter (width 100 mm) by means of at least 12,0 mm nominal size hose held at a distance of not more than 1,5 m from the appliance and with a static water pressure (with no water flow) of 200 kPa and the free height of water from the hose with stream directed upwards of not less than 10 m.

The hosing shall last at least three minutes uniformly applied around the periphery for each appliance and no water shall be detected on the inner side of the appliance.

### 5.5 Design loads

#### 5.5.1 Design pressure for glazed openings in end bulkheads of superstructures and deckhouses on or above the freeboard deck

This design pressure shall also be applied to storm shutters and deadlights in the exposed bulkheads of superstructures and deckhouses on and above the freeboard deck.

The design pressure equation in IACS UR S 3<sup>[9]</sup>, is adapted to the following equation to give design pressures  $p_D$  (kN/m<sup>2</sup>) for glazed openings and storm shutters in the end bulkheads of superstructures and in the end and side bulkheads of deckhouses on or above the freeboard deck.

Design pressure,  $p_D$  (kN/m<sup>2</sup>), shall be not less than given by the equation:

$$p_D = 10,05 \cdot a \cdot k_s \cdot (b \cdot f - h) \cdot c \quad (1)$$

The design pressures given in IACS UR S 3<sup>[9]</sup> are also included in ISO 5779<sup>[2]</sup> and BS MA 25<sup>[10]</sup>.

Definition of symbols introduced in Equation (1):

$a$  = factor relating to location and vessel length, given in Table 1;

$k_s$  = service factor

- = 1,00 for unrestricted range yacht,
- = 0,85 for intermediate range yacht,
- = 0,75 for short range yacht;

$b$  = factor based on longitudinal location, given in Table 3;

$f$  = factor based on vessel length, given in Table 2;

$h$  = height of centre of window from dsw, in m;

$c = 0,85$ ;

but in no case is the design pressure  $p_D$  (kN/m<sup>2</sup>) to be less than

— for  $L \leq 50$  m

— front positions on the uppermost continuous deck and superstructure/side shell (A) (see Table 1):

$$p_D = 30 \text{ kN/m}^2;$$

— elsewhere:

$$p_D = 15 \text{ kN/m}^2;$$

— for  $L > 50$  m

— front positions on the uppermost continuous deck and superstructure/side shell (A) (see Table 1):

$$p_D = 25 + L / 10 ; \quad \text{https://standards.iteh.ai/catalog/standards/sist/01eaf2e0-9d46-4a59-b4be-7825184d193f/iso-11336-1-2012} \quad (2)$$

— for all other locations:

$$p_D = 12,5 + L / 20 ; \quad (3)$$

where  $L$  is the load line length (m).

For a definition of the limiting significant wave heights for the above operational ranges, see 3.15 to 3.18.

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Table 1 — Values of  $a$

Location		$L$ m							
		24	30	40	50	60	70	80	90
Fronts	Superstructure or deckhouse at more than $0,02 L$ [m] above dsw	2,20	2,25	2,33	2,42	2,58	2,62	2,67	2,75
	Superstructure or deckhouse at more than $0,02 L + h_{std}$ [m] above dsw	1,20	1,25	1,33	1,42	1,50	1,58	1,67	1,75
	Superstructure or deckhouse at more than $0,02 L + 2 h_{std}$ [m] above dsw	0,67	0,70	0,77	0,83	0,90	0,97	1,03	1,10
Sides	Superstructures /Side Shell (A)	Refer to Fronts in this Table							
	Superstructures /Side Shell (B)	See Table 4							
	Deckhouses	0,67	0,70	0,77	0,83	0,90	0,97	1,03	1,10
Aft end	$x/L_p < 0,45$	0,64	0,65	0,66	0,67	0,68	0,69	0,70	0,71
	$x/L_p > 0,45$	0,32	0,33	0,34	0,35	0,36	0,37	0,38	0,39

NOTE Type (A) and Type (B) Sides/superstructures are identified as (A), not included in the assessment of the vessel's stability and buoyancy, and (B), included in the assessment of the vessel's stability and buoyancy.

See also Figure 2.

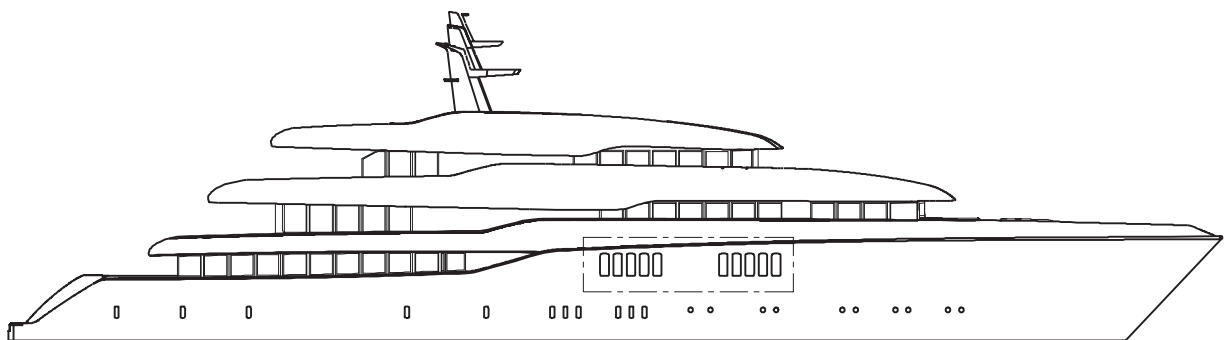


Figure 2 — Superstructure/side shell windows

Table 2 — Values of  $f$

Length $L$ m	24	30	40	50	60	70	80	90
Factor $f$	1,24	1,74	2,27	3,32	4,07	4,71	5,41	6,00