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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

Grands yachts — Résistance, étanchéité aux intempéries et étanchéité à l'eau des ouvertures vitrées —

Partie 1: Critères de conception, matériaux, encadrement 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.

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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*

— *Part 4: Non-linear / direct calculation methods for large windows (to be completed)*

— *Part 5: Glazed bulwarks, barrier and protective glazing for marine application (to be completed)*

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.

This part of ISO 11336 is suitable for the design of glazed openings on all large yachts. However where yachts carry more than 12 passengers the additional requirements (set by the appropriate marine administration) for fire integrity and damage stability are outside the scope of this standard.

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, dislocation or loss of the pane or its mounting. The scope of the scantling determination methods in 5.6 of this part of ISO 11336 is related to and limited to independent glazed openings in which the pane is supported solely by simple linear support at the edges Glazing in which the rotation at the edges is constrained more than it would be by a single bond line in accordance with Part 2 of this standard is not covered by the methods defined in 5.6..

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, and on the experience gained with application of the Large Commercial Yacht Code and RED Yacht Code Part A

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*

ISO 6721 Determination of the dynamic mechanical properties of rigid plastics

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 1863-1 - Glass in building - Heat strengthened soda lime silicate 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)*

EN 16612 - *Glass in building. Determination of the lateral load resistance of glass panes by calculation*

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 because the pane is mounted in such a way that it is isolated from deformations of the supporting structure, and the only loads on the pane are lateral pressure and effect of gravity and inertia.

3.3
not independent opening
glazed opening where the mechanical behaviour of the pane cannot be considered independent from adjacent structure, e.g. pane bonded directly into a seat in such a way that it is carrying in-plane loads or is subjected to out-of plane deformations of the supporting structure.

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 supporting structure

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
Range for which a yacht is assessed to be suitable

3.16
Operational range : unrestricted range yachts
extended distance from safe haven where conditions experienced can exceed wind force 8 (Beaufort scale), excluding extreme conditions

3.17
operational range : intermediate range yacht
distance of not more than 200 nautical miles from a safe haven,

3.18
operational Range: short range yacht
distance of not more than 60 nautical miles from a safe haven

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 less than L/4 aft 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^2 .

NOTE See Figure 1.

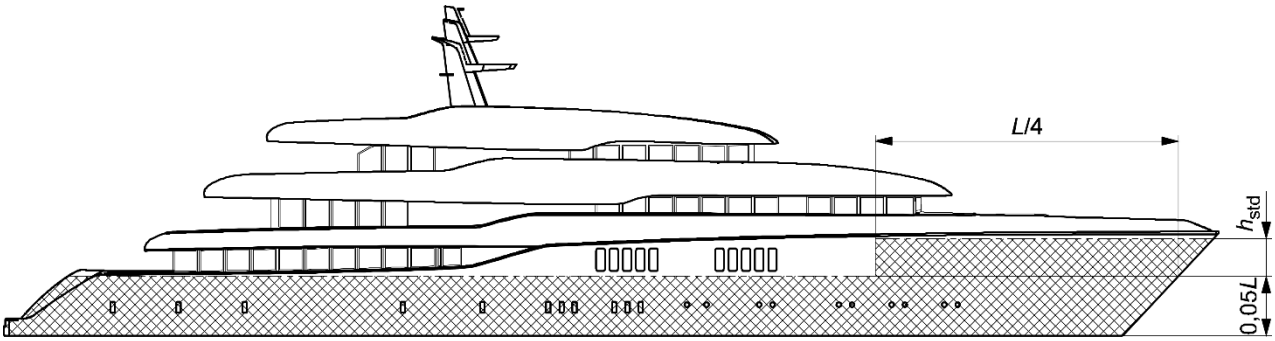

Figure 1 — Area in which glazed openings are limited to 0,85 m^2

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

3.24
weathertightness
capacity to prevent that, in any sea conditions, water will penetrate into the ship

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
for the purpose of this standard design loads are 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 3.33 to 3.42, and 3.43

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

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 glass built from thermally or chemically toughened panes.3.39

3.39
insulating glazing unit (IGU)
Insulating glazing units consist of two or more (usually glass) window panes separated by a gas-filled space to reduce heat transfer across a part of the vessel envelope. A window with insulating glass is commonly known as double glazing or a double-paned window, triple glazing or a triple-paned window, or quadruple glazing or a quadruple-paned window, depending upon how many panes of glass are used in its construction.

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 σ_C
ultimate flexural strength of *glass pane* (3.45) or *plastic material* (3.46)

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

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 without apparent plastic deformation while non-brittle plastic material will yield before breaking.

3.45
main structural section
monolithic or laminated pane construction that meets the strength requirements according to 5.2

3.46
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/σ_c, is substantially less (50 %) than that of the main structural section.

3.47
deepest seagoing waterline
dsw
either the assigned waterline for commercial yachts or the deepest seagoing waterline for private yachts

3.48
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

3.49
Superstructure type (A)
Superstructure (see 3.29) not considered buoyant in the stability calculations.

3.50
Superstructure type (B)
Superstructure (see 3.29) considered buoyant in the stability calculations.

3.51
FRP
Acronym indicating Fiber Reinforced Plastic.

4 Symbols and abbreviated terms

p_D	Design pressure following from the location on board the ship
p_{DE}	Design pressure for engineering the glass panels
p_{D0}	Base design pressure
p_{ULS}	Ultimate limit state pressure - $p_{ULS} = \gamma * p_{DE}$.
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_0	height above the waterline where design pressure equals p_{D0}
h_{std}	standard superstructure height
k_s	service factor
L_H	length of the hull
L	load line length
L_p	length between perpendiculars on summer load waterline
x	distance of centre of pane or storm shutter from aft perpendicular
t_O	basic pane thickness
a_P	unsupported long side of a rectangular pane or “equivalent long side” of a pane
b_P	unsupported short side of a rectangular pane or “equivalent short side” of a pane
β_S	pane aspect-ratio coefficient for stress
β_D	pane aspect-ratio coefficient for deflection
σ_A	allowable design flexural stress of the material
d	diameter of a circular glazed opening
σ_C	characteristic breaking strength of a material or laminate
γ	design factor
t_a	actual pane thickness
t_{min}	minimum pane thickness
$t_{p1}, t_{p2}, \ldots, t_{pn}$	ply thicknesses of a laminated pane
$t_{eq,j}$	equivalent thickness of each ply of the laminate
t_{eq}	equivalent thickness of laminated construction
t_L	physical thickness of a laminate
δ_{max}	maximum pane deflection
M	pane stiffness

l_{CD}	depth of compression layer
S_C	surface compression
N	number of test specimens
n	number of independent plies
σ_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
σ_{av}	average breaking stress or yield stress, whichever is applicable
s_x	standard deviation
C_V	coefficient of variation
Kn	statistic coefficient corresponding to lower half of the 90 % confidence limit
kN	kilonewtons
E	Young's modulus
ν	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