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Oil and gas industries including lower carbon energy — Tertiary outfitting structures

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National foreword

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International Standard

ISO 24201

Oil and gas industries including lower carbon energy — Tertiary outfitting structures

Industries du pétrole et du gaz, y compris les énergies à faible teneur en carbone — Structures d'équipement tertiaire

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 67, *Oil and gas industries including lower carbon energy*.

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Introduction

This document aims to reduce the number and variations in requirements to the minimum necessary to reflect a common and global best practice based upon existing standards and requirements. In addition, standard inventory for shapes and dimensions referred to as specifications are proposed in this document. Exemptions where requirements in common standards for tertiary items applied in offshore oil & gas projects are not met in this document are clearly stated.

The main benefits of more standardized tertiary items are expected to be reduced delivery time, more streamlined and efficient engineering, and construction as well as improved cross use of tertiary items between projects. A risk-based approach has been used when defining the proposed requirements and recommendations. The underpinning factors for determining the proposed conditions are to provide an acceptable safety level for people in combination with cost efficient solutions for implementing the requirements.

Material requirements are addressed in Clause 6 for carbon steel and Clause 7 for aluminium.

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Oil and gas industries including lower carbon energy — Tertiary outfitting structures

1 Scope

This document provides a uniform reference for tertiary structure items when a tertiary structure is designed and constructed in offshore oil and gas projects. This document covers topside systems for fixed or floating offshore projects not covered by class requirements. This document can be applicable for hull systems and onshore projects when there is consent from relevant stakeholders. This document does not provide class rules from classification societies.

This document provides requirements on dimensions of the items but does not include requirements on clearances with other structures.

The following tertiary outfitting designs for equipment items are covered in this document:

— handrails;

— safety gate;

— stairs;

— spiral stairs;

— vertical ladder;

— grating;

— access hole (manhole);

— connection method.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 148-1, *Metallic materials — Charpy pendulum impact test — Part 1: Test method*

ISO 898-1, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 1: Bolts, screws and studs with specified property classes — Coarse thread and fine pitch thread*

ISO 898-2, *Fasteners — Mechanical properties of fasteners made of carbon steel and alloy steel — Part 2: Nuts with specified property classes*

ISO 898-3, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 3: Flat washers with specified property classes*

ISO 2566-1, *Steel — Conversion of elongation values — Part 1: Carbon and low-alloy steels*

ISO 3834-2, *Quality requirements for fusion welding of metallic materials — Part 2: Comprehensive quality requirements*

ISO 5817, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections*

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ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

ISO 10474, *Steel and steel products — Inspection documents*

ISO 14122-2, *Safety of machinery — Permanent means of access to machinery — Part 2: Working platforms and walkways*

ISO 14122-3, *Safety of machinery — Permanent means of access to machinery — Part 3: Stairs, stepladders and guard-rails*

ISO 14122-4, *Safety of machinery — Permanent means of access to machinery — Part 4: Fixed ladders*

ISO 14732, *Welding personnel — Qualification testing of welding operators and weld setters for mechanized and automatic welding of metallic materials*

ISO 15609-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 1: Arc welding*

EN 485, *Aluminium and aluminium alloys — Sheet, strip and plate*

EN 10025-2, *Technical delivery conditions for non-alloy structural steels*

EN 10025-3, *Technical delivery conditions for normalized/normalized rolled weldable fine grain structural steels*

EN 10204, *Metallic products – Types of inspection documents*

EN 10210-1, *Hot finished structural hollow sections of non-alloy and fine grain steels — Part 2: Tolerances, dimensions and sectional properties*

EN 10219-1, *Cold formed welded structural hollow sections of non-alloy and fine grain steels. Technical delivery requirements*

ASTM A36, *Standard Specification for Carbon Structural Steel*

ASTM A53, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless*

ASTM A106, *Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service*

ASTM A333, *Standard Specification for Seamless and Welded Steel Pipe for Low-Temperature Service and Other Applications with Required Notch Toughness*

ASTM A370, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*

ASTM A500, *Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes*

ASTM A572, *Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel*

ASTM B209, *Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate*

API 5L, *API Specification 5L*

AWS D1.1, *Structural Welding - Steel*

AWS QC1, *Specification for AWS Certification of Welding Inspectors*

IACS W11, *Normal and higher strength hull structural steels*

JIS G3101, *Rolled steels for general structure*

JIS G3106, *Rolled steels for welded structure*

JIS G3444, *Carbon steel tubes for general structure*

JIS G3454, *Carbon steel pipes for pressure service*

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DNV rule Part 2 Material

3 Terms, definitions and abbreviated terms

3.1 Terms and definition

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1.1
handrail
device for protection against accidental fall sideways within crewed areas which stairs/step ladders or landings, platforms and walkways may be equipped with

3.1.2
guard-rail
device for protection against accidental fall sideways with all areas

3.1.3
spiral stair
stair forming a helix around a central column

3.1.4
AR
as-rolled
rolling at high temperature followed by air cooling

Note 1 to entry: The rolling finishing temperature and reduction are typically in the austenite recrystallization region and above the normalizing temperature; but they possibly are not able to be accurately controlled resulting in variable grain sizes and, hence, variable mechanical properties.

3.1.5
NR
normalizing rolling
controlled rolling procedure where the final rolling temperature is controlled within the same temperature range as for conventional furnace normalizing

Note 1 to entry: Normalizing rolling is typically followed by air cooling. The primary grain control and refining mechanism is the recrystallization of austenite following each rolling pass in the normalizing temperature range.

3.1.6
TM
thermo-mechanically controlled process
rolling procedure in which both rolling temperatures and reduction ratios and, when used, accelerated cooling conditions (AcC) are controlled

Note 1 to entry: It is characterized by high deformation ratios per rolling pass in the austenite non-recrystallization range close to the Ar3 temperature; it perhaps involves rolling in the austenite-ferrite dual phase temperature region below Ar3. After the final pass, either air cooling or accelerated cooling, excluding quenching, is used. The primary grain size and microstructural control of the fine grain structure is obtained when highly deformed austenite transforms during cooling, typically into typically ferrite, pearlite, bainite, etc.

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3.1.7
N
normalizing
separate heat treatment after rolling involving automatizing and air cooling to produce a fine-grained ferrite-pearlite microstructure

3.1.8
tertiary outfitting
not essential to the main stability and strength of the structure

Note 1 to entry: This term is used to describe members and attachments.

3.2 Abbreviated terms

CS	carbon equivalent
DC	design class
MDS	material data sheet
NDT	non-destructive testing
LC	load case
Pcm	parameter of weld crack susceptibility of base metal
pWPS	preliminary welding procedure specification
QCP	manufacturer's quality control plan
SMYS	specified minimum yield strength
SQL	steel quality level
SUS	steel use stainless
ULS	ultimate limit state
WPQR	welding procedure qualification record
WPQT	welding procedure qualification testing

4 Requirements and specifications for steel outfitting

4.1 General

This document focuses on three layers, i.e. requirements, specifications and practical drawings, as shown in Figure 1, considering operational safety and construction efficiency. The requirements are based on major international standards and requirements applied for steel tertiary items in offshore oil and gas projects.



Figure 1 — Three layers

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The specifications are based on requirements and industrial practice. The specified dimensions (specifications) provided in this document are based on either centre-to-centre (e.g. central axis from one rail to next rail) or centre-to-platform edge (e.g. central axis in rail to floor, wall or ceiling) according to industrial practice.

The carbon steel grades for tertiary items shall be selected from MDS numbers CS301 to CS308 in Annex F.

The practical drawings for fabrication are based on the specifications and fabricator's practice. These drawings can be used during the construction phase, eliminating the need to develop shop drawings from scratch. The practical drawings are given in Annex B.

4.2 Handrails

4.2.1 General

The design of the handrail shall comply with the requirements in Table 1; and the specifications should be consistently applied.

Table 1 — Specification and requirements for handrails

Parameter	Specification	Requirement(s)	Comments and limitations
Height (*a*)	— 1 100 mm (centre-to-platform distance)	— Min. 1 100 mm (top of handrail-to-platform distance)	
Height on stair (*b*)	— 1 000 mm (centre-to-platform distance)	— Min. 1 000 mm (top of handrail-to-platform distance)	Deviation with ANSI/ASSE A1264.1: 34 in to 38 in (863 mm to 965 mm)
Vertical opening (*c*)	— Max. 380 mm (centre-to-centre distance) — Max. 230 mm for lowest course (centre-to-edge distance)	— Max. 380 mm — Max. 230 mm for lowest course	
Intermediate knee rail	— Two (2) knee rails	— Min. 2 knee rails	
Diameter and thickness (*d*)	— 48 mm / 4 mm (top rail) — 34 mm / 4 mm (knee rails) — 48 mm / 6 mm (vertical stanchion)	— Min. 25 mm to max. 50 mm	Deviation with ANSI/ASSE A1264.1: 1,25 in to 2 in (32 mm to 51 mm)
Distance between vertical stanchions (*e*)	— Max. 1 500 mm (centre-to-centre distance)	— Max. 1 500 mm	
Height of toe-plate (*f*)	— 100 mm	— Min. 100 mm	
Thickness of toe plate (*g*)	— 8 mm	— 6 mm to 10 mm	
Vertical opening (gap) between toe plate and floor level (*h*)	— Max. 10 mm	— Max. 10 mm	Deviation with ANSI/ASSE A1264.1: Max. 0,25 in (6 mm)
Horizontal opening (gap) between toe plates (*i*)	— Max. 10 mm	— Continuous type (or max. 10 mm)	
Radius of rounding (*j*)	— 150 R	— 150 R	The radius is measured based on the centreline of the handrail.

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Table 1 *(continued)*

Parameter	Specification	Requirement(s)	Comments and limitations
Length of end segment from vertical stanchion (*k*)	— 350 mm	— Max. 600 mm	
Space between two segments (*m*)	— Rounding type — 77 mm (space) — 125 mm (centre-to-centre distance)	— 75 mm to 120 mm (no rounding) — 75 mm to 100 mm (rounding)	
Sharp edges	— Not allowed	— Not allowed	
Material	— Tubular type		

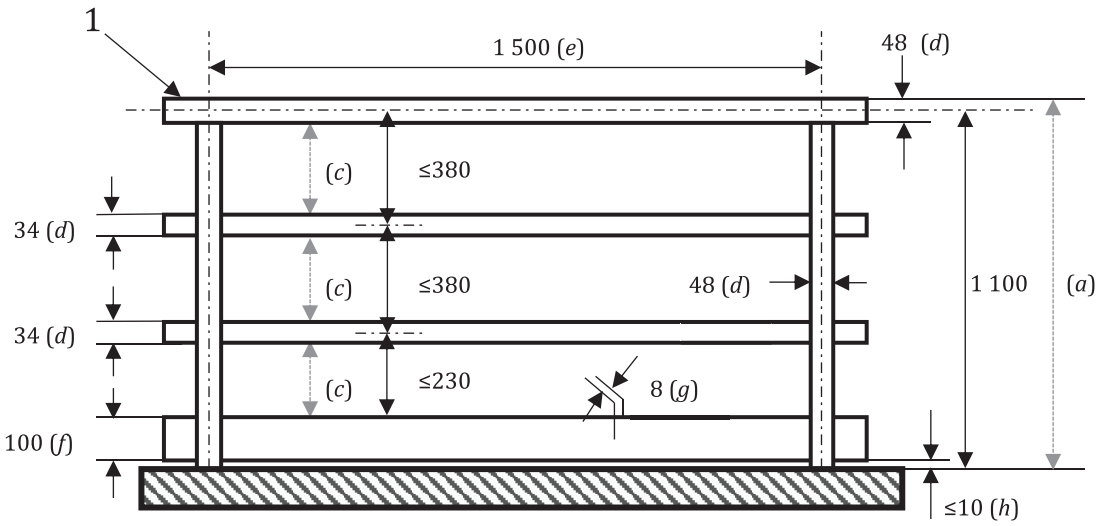
4.2.2 General requirements

The specification for typical handrails on floor or platforms is presented in Figure 2. The diameter of top rail and intermediate knee rails are defined based upon specifications for electric resistance welded (ERW) pipes.

Top rails of major egress routes shall be continuous. Although continuous type is preferred also for other areas, dis-continuous type can be applied if required to ensure structural integrity, maintainability and ease of construction.

All pipe ends shall be sealed.

Dimension in millimetres



Key

1 tubular type
a height
c vertical opening
d diameter and thickness
e distance between vertical stanchions
f height of toe-plate
g thickness of toe plate
h vertical opening (gap) between toe plate and floor level

Figure 2 — Specifications for handrails

All handrails at deck corner edges shall be inter-connected.

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The toe plate shall be provided at the bottom of handrails. If the end of the toe plate can be shaken or vibrated due to a long length without fixture, an appropriated fastening method shall be provided. The end of the toe plate extending from the fixture shall not exceed 50 mm.

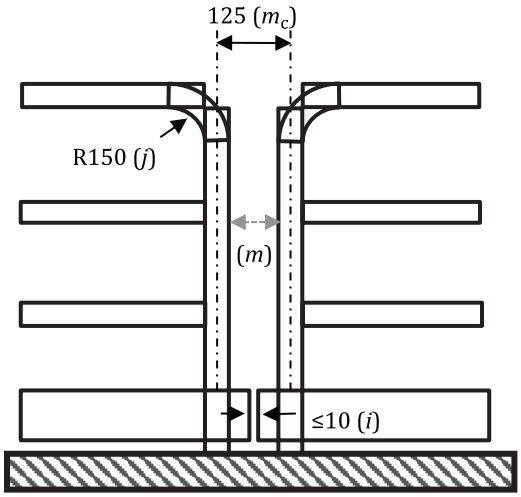
4.2.3 End of handrails

Sharp edges at the end of handrails shall be avoided to prevent any injury for workers. The specification for rounded end of handrails is shown in Figure 3.

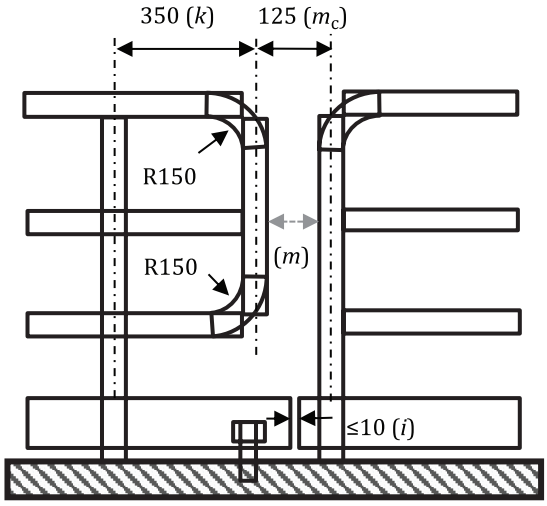
The end extension of the handrail should not be more than 600 mm to prevent occupational safety hazards. For interrupted handrails, the space between the two segments shall be 75 mm to 100 mm to prevent hand trap hazards. The centre-to-centre distance specification between the two segments is 125 mm when the diameter specification of vertical stanchion is 48 mm.

In principle, continuous toe plate on the handrail is recommended. When the toe plate can be locally bent because of its long length, it typically results in large openings (gaps) between the toe plate and the platform. In such cases, interrupted toe plates can be applied provided that the horizontal opening (gap) between two toe plates on the interrupted handrails does not exceed 10 mm.

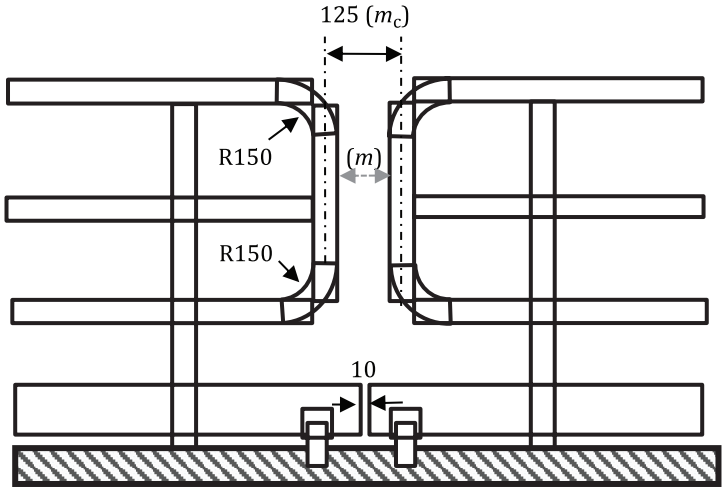
Dimension in millimetres



a) Type 1



b) Type 2



c) Type 3

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Key

i horizontal opening (gap) between toe plates
j radius of rounding
k length of end segment from vertical stanchion
m space between two segments (edge to edge distance)
m_c space between two segments (centre-to-centre distance)

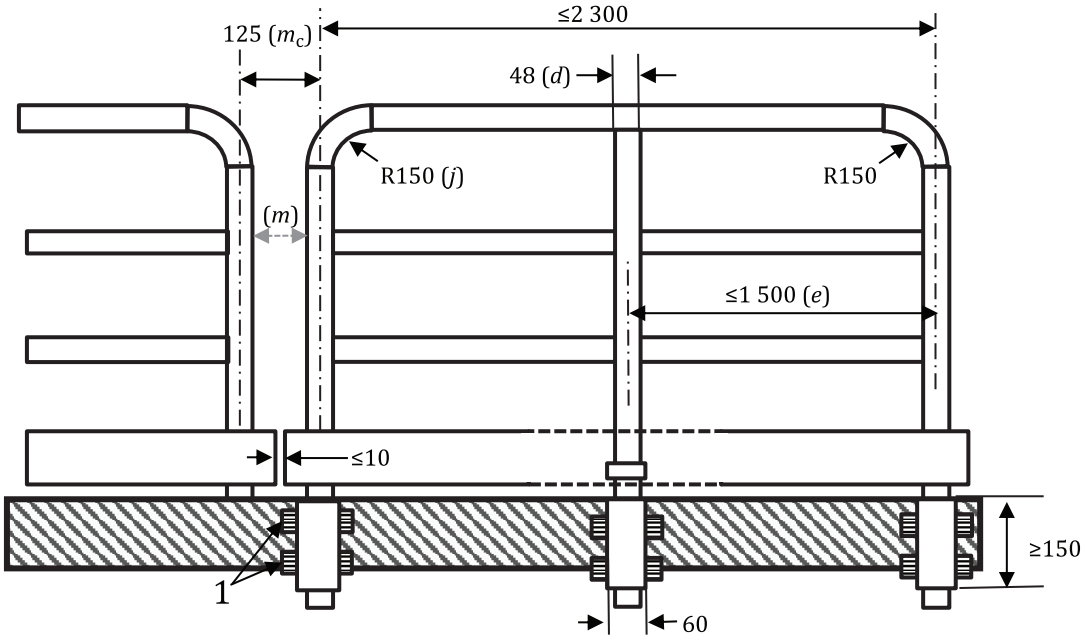
Figure 3 — Specification for rounded end of handrails

4.2.4 Removable type handrails

The dimension of removal type handrail should be equally designed with adjoined fixed handrails as shown in Figure 4. The opening (gap) between toe plates shall be less than 10 mm. The removal type handrails shall be fastened by minimum two bolts for each vertical stanchion.

The length of the removable type handrail shall not exceed 2 300 mm and the mass shall not exceed 45 kg.

Dimension in millimetres



Key

1 bolting (min. two bolts)
d diameter and thickness
e distance between vertical stanchions
j radius of rounding
m space between two segments (edge to edge distance)
m_c space between two segments (centre-to-centre distance)

Figure 4 — Specification for removable type handrails

The specification of handrails on stairs are shown in Figure 5 and Figure 6. Any jointed and bended top rails shall be rounded. The vertical stanchions on the departure and arrival platform should not exceed 350 mm from the end of the stairs.

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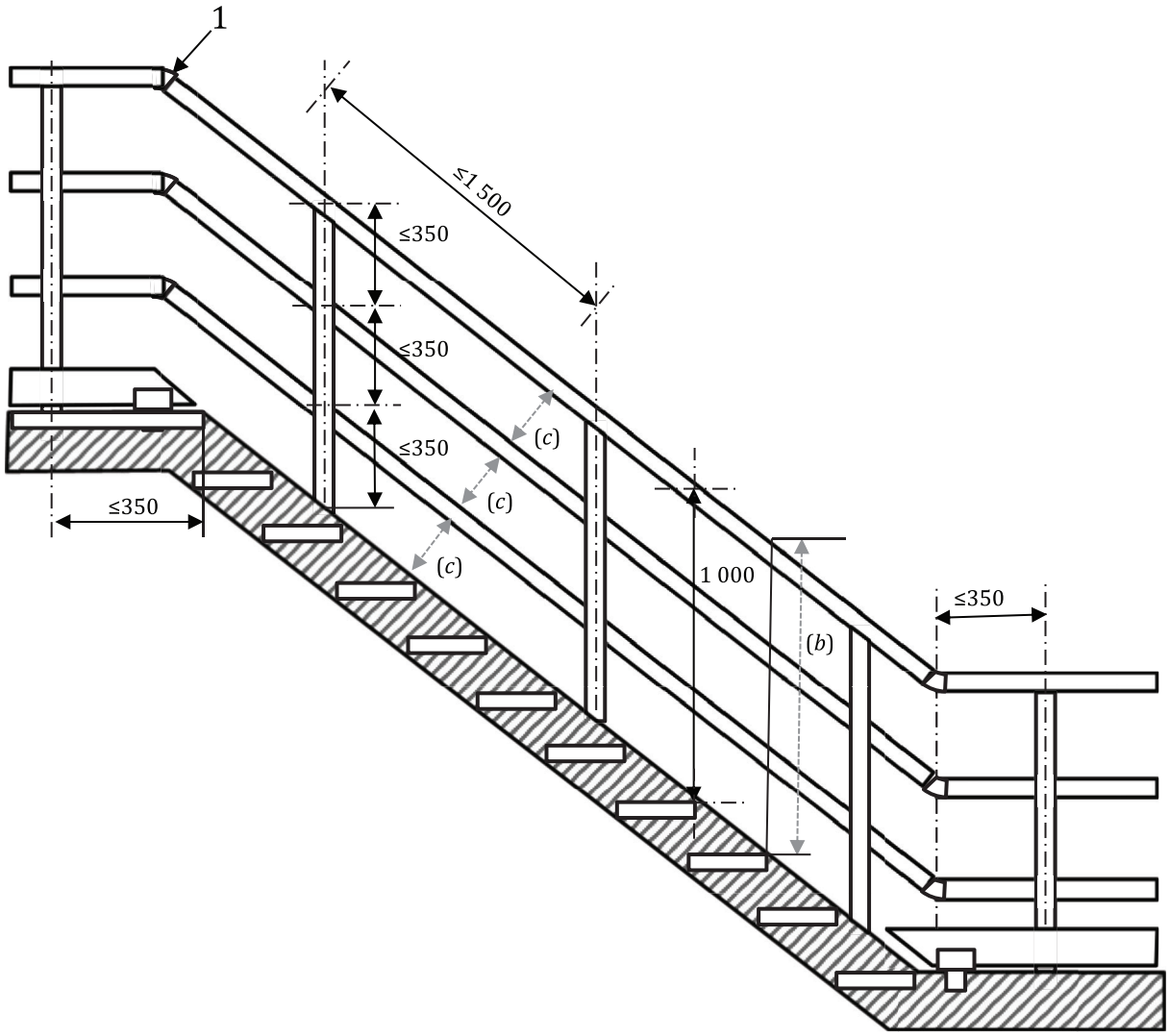
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Handrails and guard-rails shall be parallel to the pitch line of the stair flights and shall be level at open landings. The handrail shall be continuous from the top to the bottom of the stairway and shall be terminated without any sharp edge.

Handrails on flights that are 180° to each other shall have a minimum of 100 mm clear distance between rails or between rails and supporting structures, to avoid the possibility of catching hands and fingers.

Handrails shall not cause hindrance or injury to personnel. Sharp corners, rough edges, welds with burrs, etc., are not acceptable. Bolts, nuts and screws shall have a safe design, which will not catch fingers or any part of a body in motion.

Dimension in millimetres



Key

1 round type

b height on stair

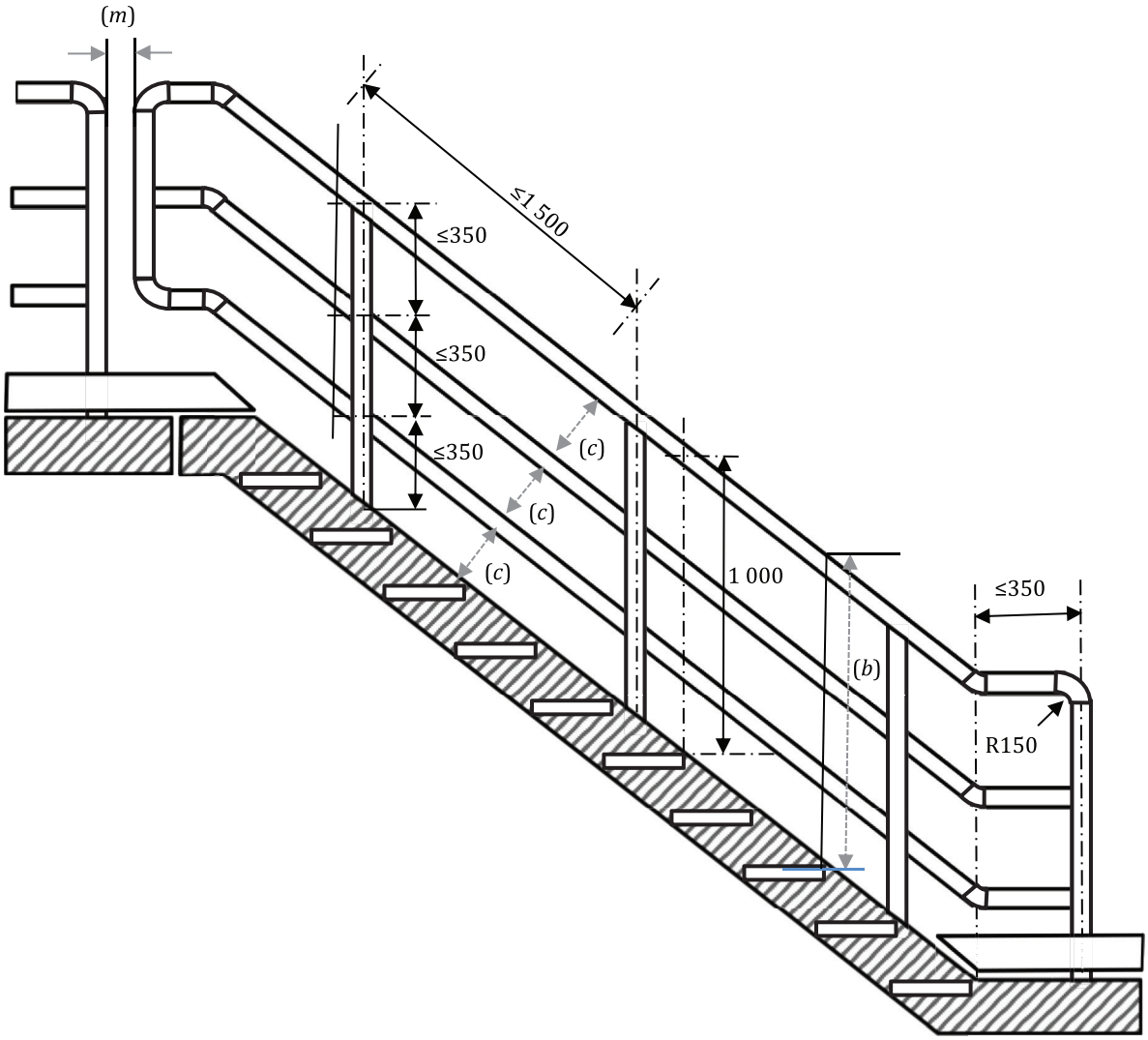
c vertical opening

Figure 5 — Specification for handrails on stairs (type 1)

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Dimension in millimetres



Key

b height on stair

c vertical opening

Figure 6 — Specification for disconnected handrails on stairs (type 2)

4.2.5 Alternative dimension and thickness of handrail

In special cases, different sizes may be used in an area. The size of the handrail may be changed if the following conditions are satisfied. See Table 2 for an examples of alternative sizes of the handrail.

— Any dimensions of handrail are within range of the requirement.

— The strength of the handrail meets the structural requirements according to test procedure.

The results were analysed based on the condition, three stanchions with top- and mid-rails, and the load case (1,5 kN) on the centre stanchion.

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Table 2 — Example of alternative size of handrail

Stanchions		Top rail		Mid rail		Distance between stanchions (mm)					
Diameter (mm)	Thickness (mm)	Diameter (mm)	Thickness (mm)	Diameter (mm)	Thickness (mm)	1 000	1 100	1 200	1 300	1 400	1 500
48	6	48	4	34	4	Y	Y	Y	Y	Y	Y
48	6	48	4	27	3	Y	Y	Y	Y	Y	N
48	6	48	4	27	3	Y	Y	Y	N	N	N
48	6	34	4	27	3	Y	N	N	N	N	N
48	4	48	4	34	4	Y	N	N	N	N	N

Key

Y acceptable

N not acceptable

4.2.6 Structural requirements

The handrails and guard-rails shall be designed for the following ultimate limit state (ULS) actions:

— a horizontal line action of 1,5 kN/m acting on the handrail;

— a point action of 1,0 kN acting in worst location and worst direction (horizontal or vertical). The point action does not act together with the horizontal line action;

— actions from possible attachments shall be established for each case;

— actions on guard-rails and flexible barriers in areas with cargo handling should be determined with due attention to relevant operational conditions.

A load factor of 1,3 shall be applied to the above ULS actions.

4.2.7 Tests of handrails

The test shall conform to the requirement of test procedure as described in Clause 10.

4.3 Self-closing safety gate

4.3.1 General

The design of the safety gate shall conform to the requirements in Table 3; and the specifications should be consistently applied.

Table 3 — Specification and requirements for self-closing safety gate

Parameter	Specification	Requirement(s)	Comments and limitations
Height (*a*)	— 1 100 mm (centre-to-centre distance)	— Min. 1 100 mm	Equal height with handrail
Horizontal clearance (*b*)	— 750 mm (centre-to-centre distance)	— Max. 800 mm	
Clear opening (*c*)	— 650 mm	— Min. 650 mm	
Gate width (*d*)	— 550 mm (centre-to-centre distance)	— Min. 550 mm	
Diameter	— 48 mm (top rail) — 33 mm (knee rails)	— Min.25 mm to max. 50 mm	
Hinge type (*e*)	— Self-closing by spring or gravity type hinge	— Self-closing by spring or gravity type hinge	

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Table 3 *(continued)*

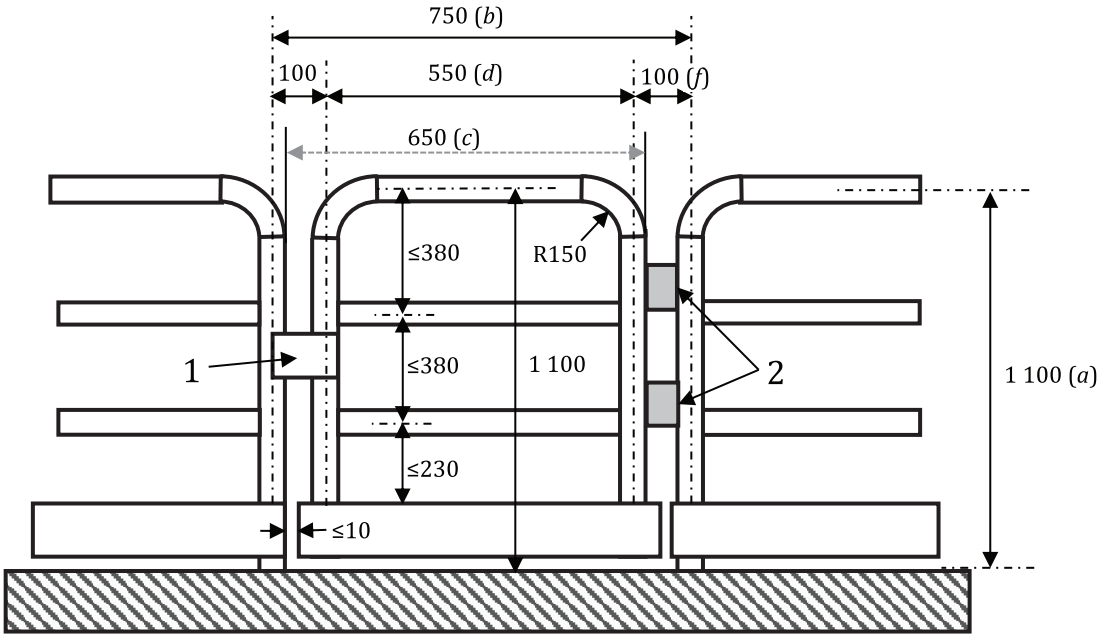
Parameter	Specification	Requirement(s)	Comments and limitations
Space between safety gate and adjoined segment (*f*)	— Rounding type — 52 mm (space) — 100 mm (centre-to-centre distance)	— 50 mm to 80 mm (rounding)	
Firm stopper (*g*)	— Firm stopper on middle of the gate.	— Firm stopper on middle of the gate.	
Opening direction	— Easy open onto the platform or floor	— Easy open onto the platform or floor	

The height of self-closing safety gate should be the same to adjoined guide-rails or handrails. The clear opening between vertical stanchion and hinge of the safety gate shall be no less than 650 mm as shown in Figure 7. The space between handrail and safety gate shall be 50 to 80 mm as per the requirements between two segments for handrails. The opening (gap) between toe plate on safety gate and adjoined handrail shall be less than 10 mm.

The safety gate shall be self-closed by spring or gravity force. The gate shall be easily opened onto the platform or floor. A firm stopper shall be provided at the side of the gate to prevent users falling through the opening.

This self-closing gate shall be installed at the top of vertical and inclined ladders to prevent a falling hazard.

Dimension in millimetres



Key

1 firm stopper (g)
2 spring/gravity (e)
a height
b horizontal clearance
c clear opening
d gate width
f space between safety gate and adjoined segment

Figure 7 — Specification of safety gate

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4.3.2 Structural requirements

The structural requirements shall conform to the requirement of handrails as described in 4.2.6.

4.3.3 Tests of handrails

The test shall conform to the requirement of test procedure as described in Clause 10.

4.4 Stairs

4.4.1 General

The requirements in Table 4 shall be applied to all stairs on an installation except stairs providing means of access to machinery or equipment skids; and the specifications should be consistently applied. Stairs in infrequently accessed areas such as inside a ballast tank and splash zone is not covered in this document.

Table 4 — Specification and requirements for stairs

Parameter	Specification	Requirement(s)	Comments and limitations
Stairway slopes (α)	— 38°	— 30° to 40°	
Width (w)	— Normal access: 1 000 mm — Secondary stairs: 800 mm — Primary stairs: 1 200 mm — ≥ 50 persons: 1 500 mm — Stairs on access route between helideck and heli-admin: 1 500 mm	— Normal access: min. 1 000 mm — Secondary stairs: min. 800 mm — Primary stairs: min. 1 200 mm — ≥ 50 persons: min. 1 500 mm — Stairs on access route between helideck and heli-admin: min. 1 500 mm	Access width in machinery area can upon agreement be min. 600 mm. Min. 1 100 mm if stretcher (length × width = 2 200 mm × 650 mm) handling is required and/or for escape ways.
Head height (a)	— Min. 2 300 mm	— Min. 2 300 mm	
Clearance (b)	— Min 1 900 mm	— Min 1 900 mm	Absolute minimum clear distance between any obstacle and the pitch line.
Step overlap (r) (Nosing)	— Min. 10 mm — Nonslip finish	— Min. 10 mm — Nonslip finish	Deviation with NORSOK C-002: Min. 20 mm
Climbing - height per flight (H)	— Max. 3 000 mm for multi flight — Max. 4 000 mm for single flight	— Max. 3 000 mm for multi flight — Max. 4 000 mm for single flight	
Number of rises	— Max. 16 for multi flight — Max. 22 for single flight	— Max. 16 for multi flight — Max. 22 for single flight	
Rise height (h)	— Max 190 mm	— Max 190 mm	
Going (g) and rise (h)	— $600 \leq g + 2\,h \leq 660$ mm	— $600 \leq g + 2\,h \leq 660$ mm	In the case where it is not possible to maintain the height of the rise between the level of departure and the first step, it may be reduced by a maximum of 15 %.

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Table 4 *(continued)*

Parameter	Specification	Requirement(s)	Comments and limitations
Toe plate on tread (*c*)	— 50 mm	— Min 50 mm	Back covers are recommended to be fitted for stairways inside of the living quarters.
Toe plate on landing (*d*)	— 100 mm	— Min 100 mm	
Uppermost step	— The uppermost step shall be level with the landing.	— The uppermost step shall be level with the landing.	
Length of landing area	— Min. 800 mm, Stair width ≤ landing length (depth) — Min. 1 500 mm if stretcher handling is required and/or for escape ways.	— Min. 800 mm, Stair width ≤ landing length (depth) — Min. 1 500 mm if stretcher handling is required and/or for escape ways.	Sufficient landing length should be ensured in the main access way and escape way for standard stretcher (length × width = 2 200 mm × 650 mm) handling and safe escape. Stairway landings shall be sized to ensure at the minimum clearance is not impacted in way of doors that may open into the landing.

4.4.2 General requirements

The handrails on stairs shall conform to requirements of handrails in 4.2.

To limit the lateral buckling and displacements, the small cross bracings between the stringers shall be provided on hinged stairways, stairs in the splash zone and when the height between two flights exceeds 2 000 mm.

4.4.3 Stair width and headroom clearances

The width of stairs should be designed based on purpose and personnel traffic as shown in Figure 8. For normal access, the width of stairs should be minimum 1 000 mm and for secondary access, the width should be minimum 800 mm. In the case of areas with low access frequency and no specific requirements for material handling such as an uncrewed machinery area, the width can be reduced based on project agreement, but the width shall not be less than 600 mm.

If standard stretcher (length x width = 2 200 mm x 650 mm) handling is required on the stairs, the width shall be minimum 1 100 mm. When bigger stretchers are used, the minimum width shall be assessed in advance before construction.

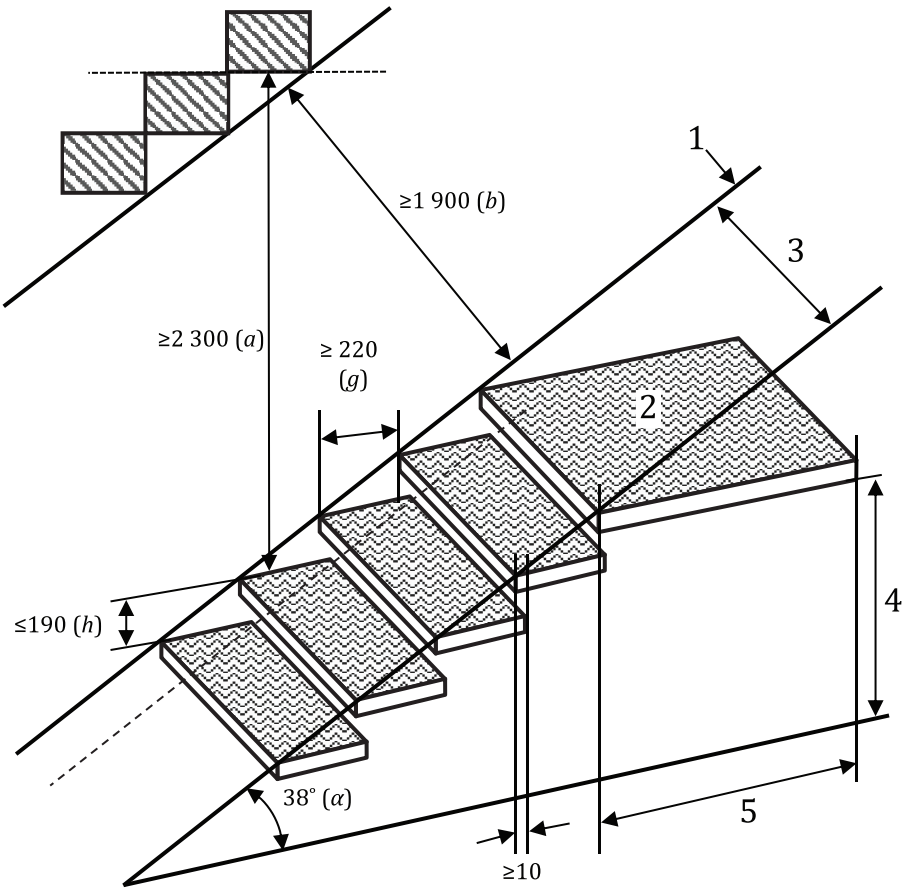
For stairs used for escape and primary access, the width shall be minimum 1 200 mm. Stairs designed for through traffic of more than 50 persons in escape situations shall have a minimum net width of 1 500 mm. The minimum width shall be measured between the inside of handrails.

Head height from tread to any obstacle shall not be less than 2 300 mm and absolute minimum clear distance between any obstacle and the pitch line, measured at an angle of 90° from the pitch line shall not be less than 1 900 mm.

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Dimension in millimetres



Key

1 pitch line
2 landing depth ≥ width of stair
3 ≥ 1 000 (normal access)
≥ 800 (secondary stairs)
≥ 1 200 (primary stairs)
≥ 1 500 (≥ 50 persons)
4 ≤ 3 000(multi flight)
≤ 4 000 (single)
5 ≥ 1 000(normal access)
≥ 800 (secondary stairs)
≥ 1 200 (primary stairs)
≥ 1 500 (≥ 50 persons)
α stairway slopes
a head height
b clearance
g going
h rise

Figure 8 — Recommended overall dimension for stairs

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4.4.4 Nosing

All nosing shall have a non-slip surface such as anti-slip panel, with secure and permanent fixing on top of the flooring material, unless the selected material itself has a built-in nosing. The nosing shall be flush with the stair tread surface.

Internal stairs shall have nosing that allow efficient cleaning. The nosing should be painted with contrasting colour (yellow preferred) when the stairs are used as primary escape and main access way. Additionally, a photo luminescent stairway marking is recommended to the nosing of the stairs on primary escape routes.

4.4.5 Treads and landings

Each stairway shall have a landing at the top and bottom of every flight. There shall be an intermediate landing when two or more flights converge between deck levels. The depth, *h*, of the landing shall not be less than the width, *g*, of the stair.

Treads shall be evenly spaced. The maximum allowable deviation of the rise dimension in a single flight of stairs is ±5 mm, including the first and last riser of every flight. Where it is not possible, the rise of the first step in the flight, may be reduced by maximum of 15 % (see Figure 9).

Treads shall withstand a foot load of 2 000 N on an area of 100 mm × 100 mm at any position without permanent deflection.

Dimension in millimetres

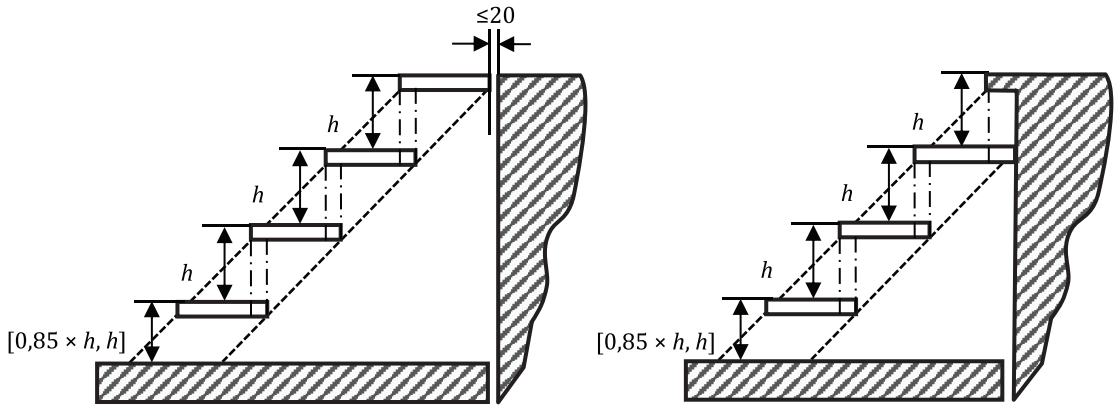


Figure 9 — Specification for height of rises and positioning of the uppermost step

All treads shall have a toe plate of minimum 50 mm height. All landings shall have a toe plate of minimum 100 mm height. Openings between toe plate and decks or gratings shall not exceed 10 mm (see Figure 10).

The overlap of the steps shall be more than 10 mm and shall apply equally to landings and floors.

Formula (1) is applicable for determining the stair proportion:

$$600 \leq g + 2\,h \leq 660 \tag{1}$$

where

g is the going;

h is the rise.

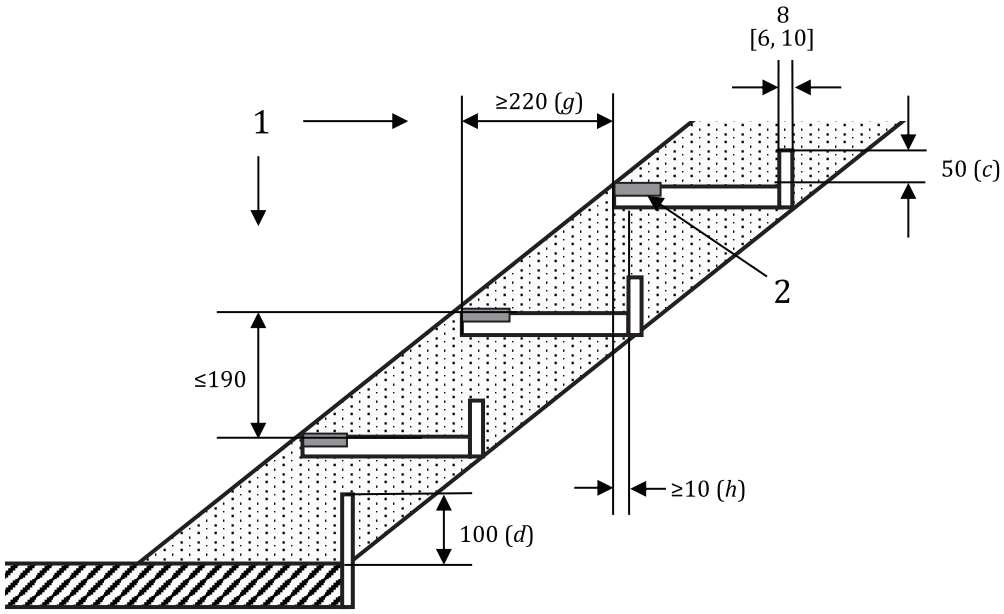
The maximum rise shall not exceed 190 mm and the going shall not be less than 240 mm. For special case, however, where the slope is between 38 and 40 degree, the minimum going is 220 mm due to the maximum height of rise.

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The minimum rise height is 160 mm and first step (the lowest step) may be reduced by a maximum of 15 % of equal riser height.

Dimension in millimetres



Key

1 rise and going: $600 \leq g+2\,h \leq 660$ pitch line

2 non-slop nosing (contrasting colour marking, such as yellow, or photoluminescence on primary escape way and main access way)

c toe plate on tread

d toe plate on landing

g going

r step overlap

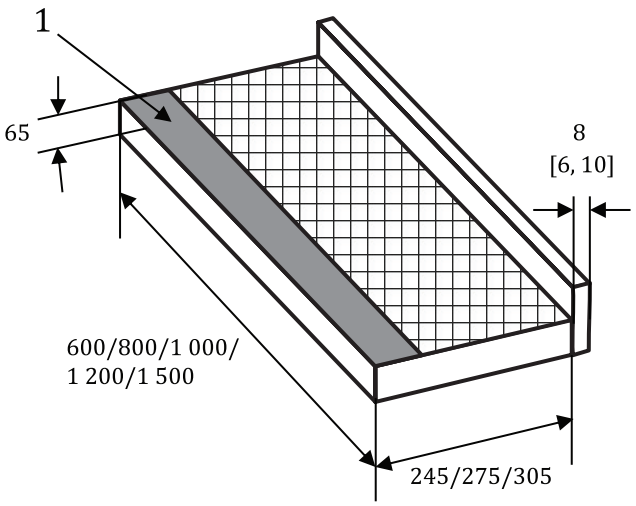
Figure 10 — Specification for riser and going for stairs

Figure 11 shows the specification for treads. The width specification is 600 mm, 800 mm, 1 000 mm, 1 200 mm and the going specification is 245 mm, 275 mm, 305 mm. The width in the going direction of the non-slip nosing on stairs shall not be less than 25 mm.

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Dimension in millimetres



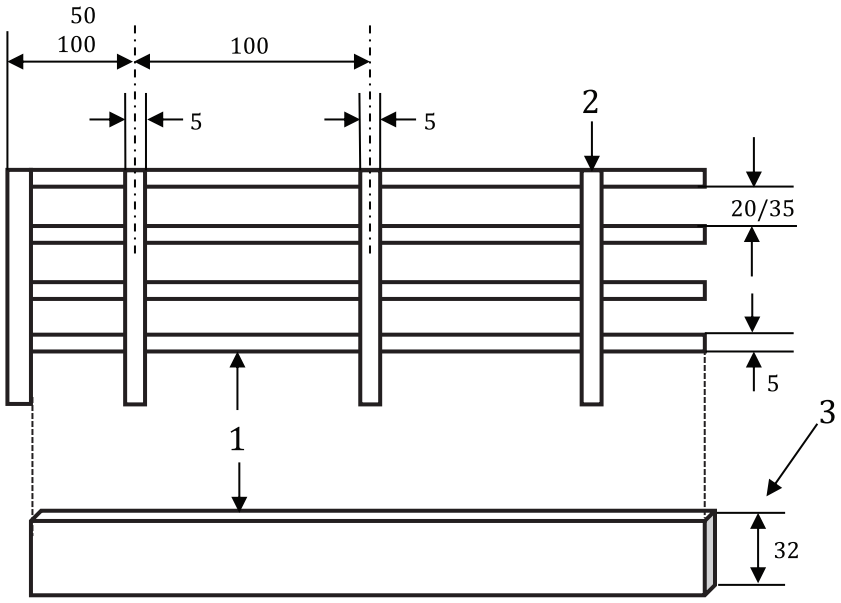
Key

1 non-slip nosing including yellow marking or photoluminescence on primary escape way and main access way

Figure 11 — Specification for riser and going for stairs

Figure 12 shows the specification for serrated steel grating. The thickness specification of cross and bearing bar is 5 mm. The depth specification of the bearing bar is 32 mm. Other dimensions shall conform to the requirements of grating in Table 8.

Dimension in millimetres



Key

1 bearing bar
2 cross bar
3 depth

Figure 12 — Specification for riser and going for stairs

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4.4.6 Structural requirements

Treads shall withstand a foot load of 2 000 N on an area of 100 mm × 100 mm at any position without permanent deflection.

4.4.7 Tests of stairs

The test shall conform to the requirement of test procedure as described in Clause 10.

4.5 Spiral stairs

4.5.1 General

The requirements of Table 5 shall be applied to all spiral stairs on an installation except stairs providing means of access to machinery or equipment skids; and the specifications should be consistently applied.

Table 5 — Specification and requirements for spiral stairs

Parameter	Specification	Requirement(s)	Comments and limitations
Width	— Normal access: 1 000 mm — Primary stairs: 1 200 mm — ≥ 50 persons: 1 500 mm	— Normal access: min. 1 000 mm — Primary stairs: min. 1 200 mm — ≥ 50 persons: min. 1 500 mm	Min. 1 000 mm if stretcher (length × width = 2 200 mm × 650 mm) handling is required and/or for escape ways.
Head height	— Min. 2 300 mm	— Min. 2 300 mm	
Step overlap (Nosing)	— Min. 10 mm — Nonslip finish	— Min. 10 mm — Nonslip finish	
Number of rises	— Max. 16 for multi flight — Max. 22 for single flight	— Max. 16 for multi flight — Max. 22 for single flight	
Rise height	— Max 190 mm	— Max 190 mm	
Going (g) and rise(h)	— $480 \leq g + 2\,h \leq 800$ mm	— $480 \leq g + 2\,h \leq 800$ mm	In the case where it is not possible to maintain the height of the rise between the level of departure and the first step, it may be reduced by a maximum of 15 %.
Toe plate on tread	— 50 mm	— Min 50 mm	Back covers are recommended to be fitted for stairways inside of the living quarters.
Toe plate on landing	— 100 mm	— Min 100 mm	
Uppermost step	— The uppermost step shall be level with the landing.	— The uppermost step shall be level with the landing.	
Angle for landing	— Landing at platform levels angle: 90° — Intermediate or rest landings angle: 45°	— Landing at platform levels angle ≥ 90° — Intermediate or rest landings angle ≥ 45°	Angle at the geometric centre on plan

4.5.2 General requirements

The handrails on spiral stairs shall conform to the requirements of handrails as outlined in 6.2.

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Both inner and outer handrails shall be provided.

4.5.3 Sizes of stairs

In principle, two stair categories are specified as described in Table 6.

The outside diameter should be determined considering clear access widths, distance between the handrail and any obstruction as well as diameter of centre support column.

Table 6 — Sizes of stairs

Stair category	Minimum outside diameter (mm)	Rise, h (mm)	Going, g (mm)			$2h + g$ (mm)		Clear width (mm)
			Minimum inner going, g_i	Minimum centre going, g_c	Minimum outer going, g_o	Min.	Max.	Min.
Type 1	2 500	160-190	150	250	450	480	800	1 000
Type 2	2 900	160-190	150	250	450	480	800	1 200

The minimum clear width of a stairway shall be measured between the inside of inner and outer handrails.

The rise and going should be determined based on Formula (2):

$$480 \leq g + 2 \times h \leq 800 \quad (2)$$

where

g is the going;

h is the rise.

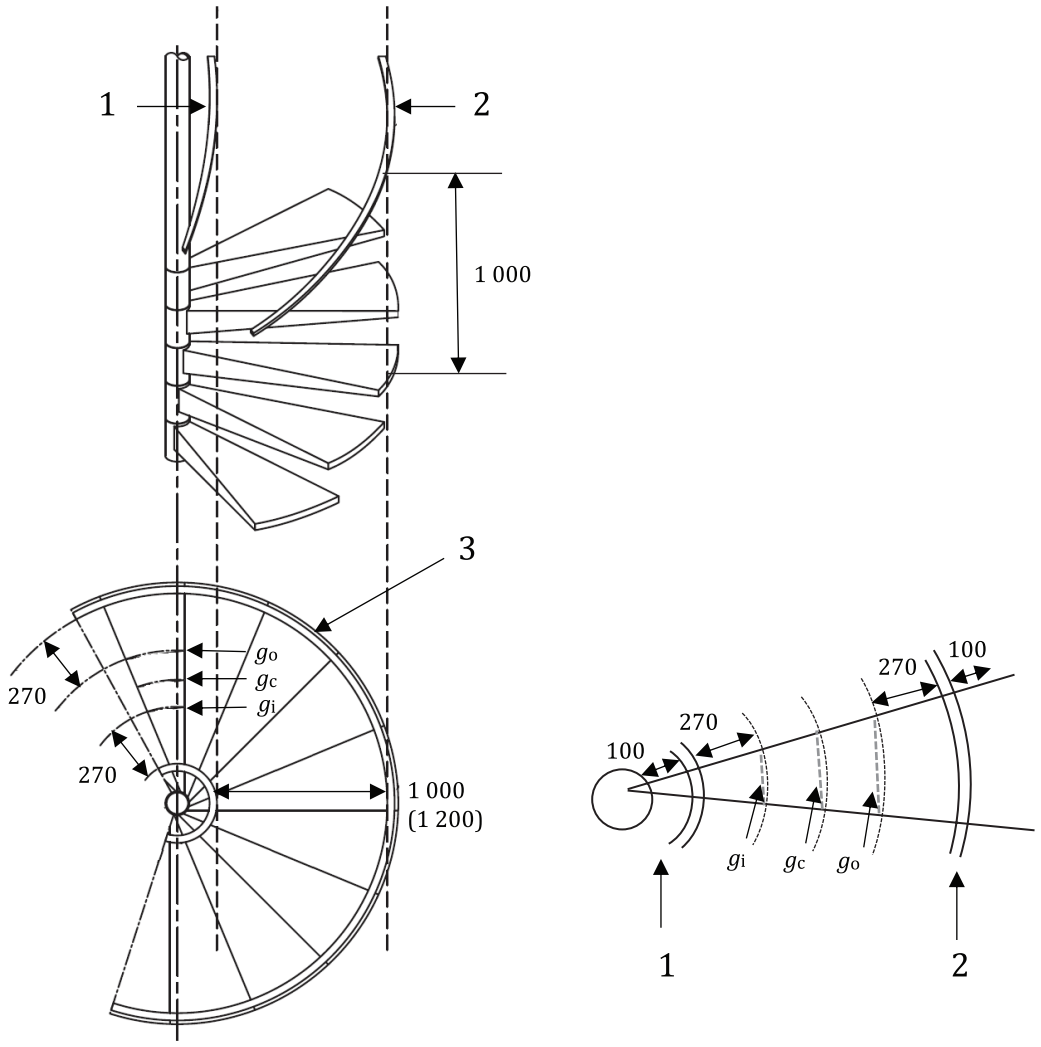
The maximum rise shall not exceed 190 mm and the maximum number of risers in a single flight should be 16, except where it is not practicable to fit in intermediate landings at 16 riser intervals. In such cases the number of risers may be increased to 22.

The inner going, which is the minimum going, should be measured at a point 270 mm horizontally from the inner handrail or from the column face where no inner handrail is fitted (see Figure 13).

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Dimension in millimetres



Key

1 inner handrail
2 outer handrail
3 g_i: inner going
g_c: centre going
g_o: outer going

Figure 13 — Measurement of clear width and goings

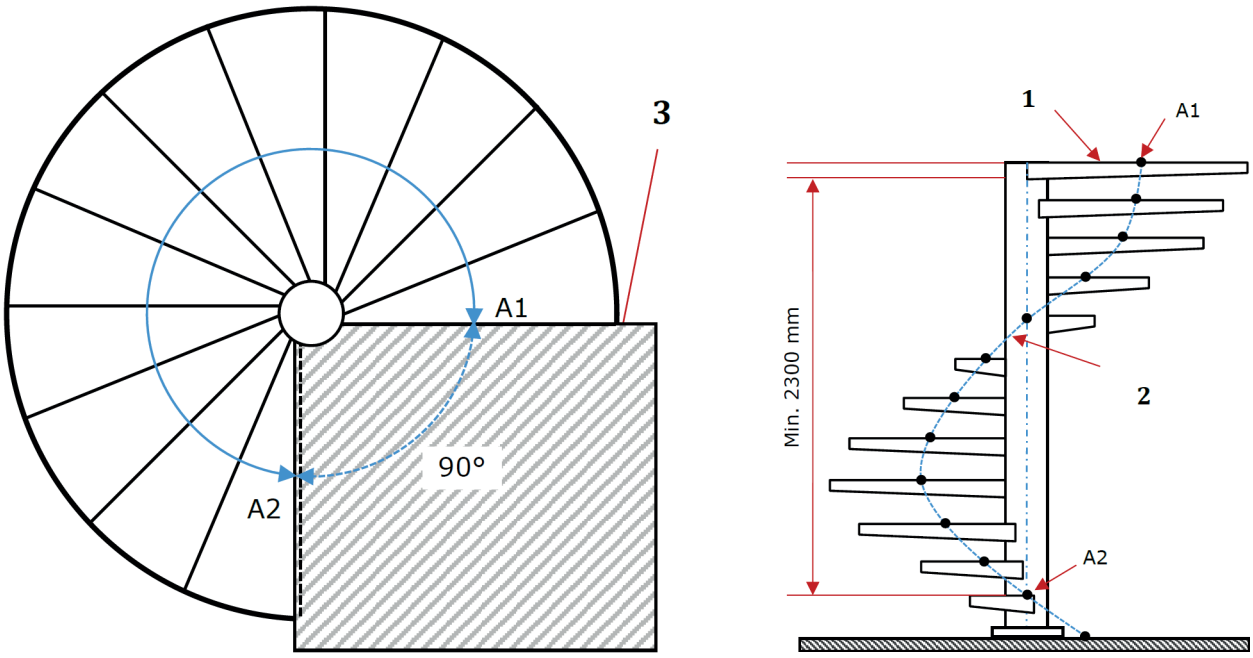
The centre going should be measured at the central point of the clear width. The outer going, which is the maximum going, should be measured at a point 270 mm horizontally from the outer handrail or string, whichever is the least radius.

The clear headroom should not be less than 2 300 mm, but it may be reduced to 2 100 mm wherever this is not practicable, e.g. at a distance 150 mm or less from the inner handrail across the tread (see Figure 14).

Landings at platform levels should subtend an angle of not less than 90° at the geometric centre on plan. Intermediate or rest landings should have a plan area of not less than two consecutive treads or subtend an angle of 45° at the geometric centre on plan, whichever is the greater.

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a) Plan **b) Elevation**

Key

1 landing
2 pitch line
3 landing at platform level

Figure 14 — Clear headroom

4.5.4 Nosing

All nosings shall have a non-slip surface such as anti-slip panel, with secure and permanent fixing on top of the flooring material, unless the selected material itself has a built-in nosing and anti-slip panel can be used as an alternative. The nosings shall be flush with the stair tread surface.

4.5.5 Treads and landings

Each stairway shall have a landing at the top and bottom of every flight. There shall be an intermediate or rest landing when two or more flights converge between deck levels when the spiral stairs installed inside a structure such as a column pass through multiple decks.

Treads shall be evenly spaced. The maximum allowable deviation of the rise dimension in a single flight of stairs is ±5 mm, including the first and last riser of every flight. Where it is not possible, the rise of the first step in the flight, may be reduced by maximum of 15 % of equal riser height.

Treads shall withstand a foot load of 2 000 N on an area of 100 mm × 100 mm at any position without permanent deflection.

All treads shall have a toe plate of minimum 50 mm height. All landings shall have a toe plate of minimum 100 mm height. Openings between toe plate and decks or gratings shall not exceed 10 mm.

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4.6 Vertical ladders

4.6.1 General

The design of the vertical ladders shall conform to the requirements in Table 7; and the specifications should be consistently applied.

Table 7 — Specification and requirements for vertical ladders

Parameters	Specification	Requirement(s)	Comments and limitations
Spacing between successive rungs (*a*)	— 300 mm /290 mm /280 mm (centre-to-centre distance)	— 225 mm to 300 mm	
Spacing between the lowest rung and the departure area (*b*)	— 100 mm to 300 mm (centre-to-floor distance)	— 100 mm to 400 mm	Recommendation is 225 mm to 300 mm
Width of ladder (*c*)	— 450 mm (centre-to-centre distance)	— 410 mm to 600 mm	
Rung shape	— Diamond type	— Diamond type	
Dimension (or diameter) of rungs	— 22 mm	— 22 mm to 50 mm	
Cross-section profile of stiles (stringer) (dimension or diameter)	— Flat bar — Width: 65 mm — Thickness: 12 mm — Pipe as length ≤ 3 000 mm without intermediate support — Diameter: 48,3 mm — Thickness: 3,7 mm — Pipe as 3 000 mm < length ≤ 5 000 mm without intermediate support — Diameter: 89,1 mm — Thickness: 5,5 mm — Pipe as 5 000 mm < length ≤ 10 000 mm with one intermediate support — Diameter: 89,1 mm — Thickness: 5,5 mm	— Flat bar with max. 80 mm width and min. 10 mm thickness — Pipe with min. 48 mm diameter and min. 3,7 thickness when length is less than 3 000 mm — Pipe with min. 89 mm diameter and min. 5,5 thickness when length is larger than 3 000 mm	Length without intermediate support is less than 3 000 mm for flat bar type Length without intermediate support is less than 5 000 mm for pipe type
Location of the lowest part of safety cage (*d*)	— 2 300 mm	— 2 200 mm to 2 500 mm	Deviation with ANSI/ASSE A1264.1: 7 in to 8 in (2 133 mm to 2 438 mm); AS 1657:2018: 2 000 mm to 2 200 mm
Clear distance within safety cage hoop (*e*)	— 650 mm to 800 mm	— 650 mm to 800 mm	Deviation with AS 1657:2018: min. width 700 mm, min. depth 750 mm

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Table 7 *(continued)*

Parameters	Specification	Requirement(s)	Comments and limitations
Clear distance within the lowest part of safety cage hoop (*f*)	— 715 mm to 880 mm (max. 110 % of *e*)	— 715 mm to 880 mm (max. 110 % of *e*)	
Horizontal distance from the surrounding structure (safety cage) to centreline of ladder (*g*)	— 325 mm to 400 mm	— 325 mm to 400 mm	
Vertical distance between two hoops of safety cage (*h*)	— 1 500 mm (centre-to-centre distance)	— Max. 1 500 mm	
Distance between two uprights of safety cage (*i*)	— 300 mm (centre-to-centre distance)	— Max. 300 mm	Deviation with AS 1657:2018: max. 150 mm when vertical opening is 2 000 mm
Opening area of safety cage (*j*)	— Max. 0,40 m^2	— Max. 0,40 m^2	
Extension from arrival area (*k*)	— Safety cage: min. 1 100 mm (height of handrail) — Ladder for side access: — min. 5 rungs — Min. 1 400 mm (280 mm × 5)	— Safety cage: min. 1 100 mm (height of handrail) — Ladder for side access: — min. 5 rungs — Min. 1 400 mm (280 mm × 5)	Extension is measured from arrival. Extension of ladder should be required when no good handholds are provided
Space between the ladder and any permanent obstruction (measured from the front of the rungs) (*m*)	— in front of the ladder: min. 650 mm min. 600 mm in case of a discontinuous obstacle — behind the front side of the rungs: min. 200 mm min. 150 mm in case of a discontinuous obstacle	— in front of the ladder: min. 650 mm min. 600 mm in case of a discontinuous obstacle — behind the front side of the rungs: min. 200 mm min. 150 mm in case of a discontinuous obstacle	In areas where the use of self-contained breathing apparatus is required through risk assessment, sufficient space should be secured.
Toe clearance space between the walk-through ladder and any permanent obstruction (measured from behind of the rungs) (*n*)	— Min 150 mm — Min. 75 mm in case of a discontinuous obstacle — Upper rung: 60 mm to 75 mm	— Min 150 mm — Min. 75 mm in case of a discontinuous obstacle — Upper rung: 60 mm to 75 mm	Walk through ladders
Distance between the side access ladder stile and landing platform in the case of side access (*p*)	— 150 mm to 250 mm	— 150 mm to 250 mm	Side access ladder

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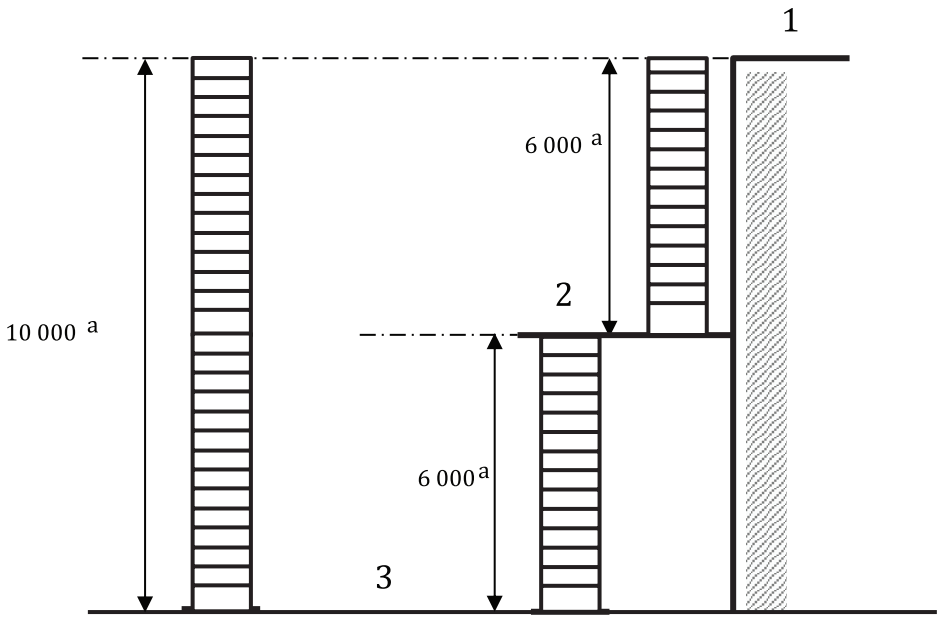
Table 7 *(continued)*

Parameters	Specification	Requirement(s)	Comments and limitations
Number of fixing support for flat bar type stile	— Min. 2 m (< 3 m) — Min.one additional support for every 3 m (> 3 m)	— Min. 2 m (< 3 m) — Min.one additional support for every 3 m (> 3 m)	Ladder stile with flat bar and pipe type only
Ladder height without rest platform (single flight)	— Max. 10 000 mm	— Max. 10 000 mm	Deviation with AS 1657:2018: Max. 6 000
Ladder height with staggered flights	— Max. 6 000 mm	— Max. 6 000 mm	

4.6.2 General requirements

Ladder height without intermediate platform or rest platform shall not exceed 10 000 mm for single flight and with staggered flights shall not exceed 6 000 mm (see Figure 15). A single flight exceeding 6 000 mm shall be equipped with a guided type fall arrester on a rigid anchorage line (fall arrester).

Dimension in millimetres



Key

1 arrival area
2 intermediate platform or rest platform
3 departure area
a Maximum.

Figure 15 — Height of flights and location of platforms

Figure 16 shows the specification for side access type vertical ladders. Figure 17 shows the specification for walk-through type vertical ladders. For safe access, the side access type is recommended. The recommendation is not applicable to vertical ladders within tanks and void spaces.

In areas where the use of self-contained breathing apparatus is required through risk assessment, sufficient clear distance within safety cage hoop should be secured.

The spacing between successive rungs shall be between 225 mm and 300 mm. The spacing specification of 300, 290, 280 mm provides flexibility due to different lengths of the vertical ladder (see Figure 16).

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The vertical ladder shall provide a safe access without any slipping hazard prevented by the shape of the rungs. Circular rungs are more prone to slipping and are consequently not allowed.

For side access type, the ladder shall be extended at least 5 rungs and be minimum 1 400 mm height for safe access.

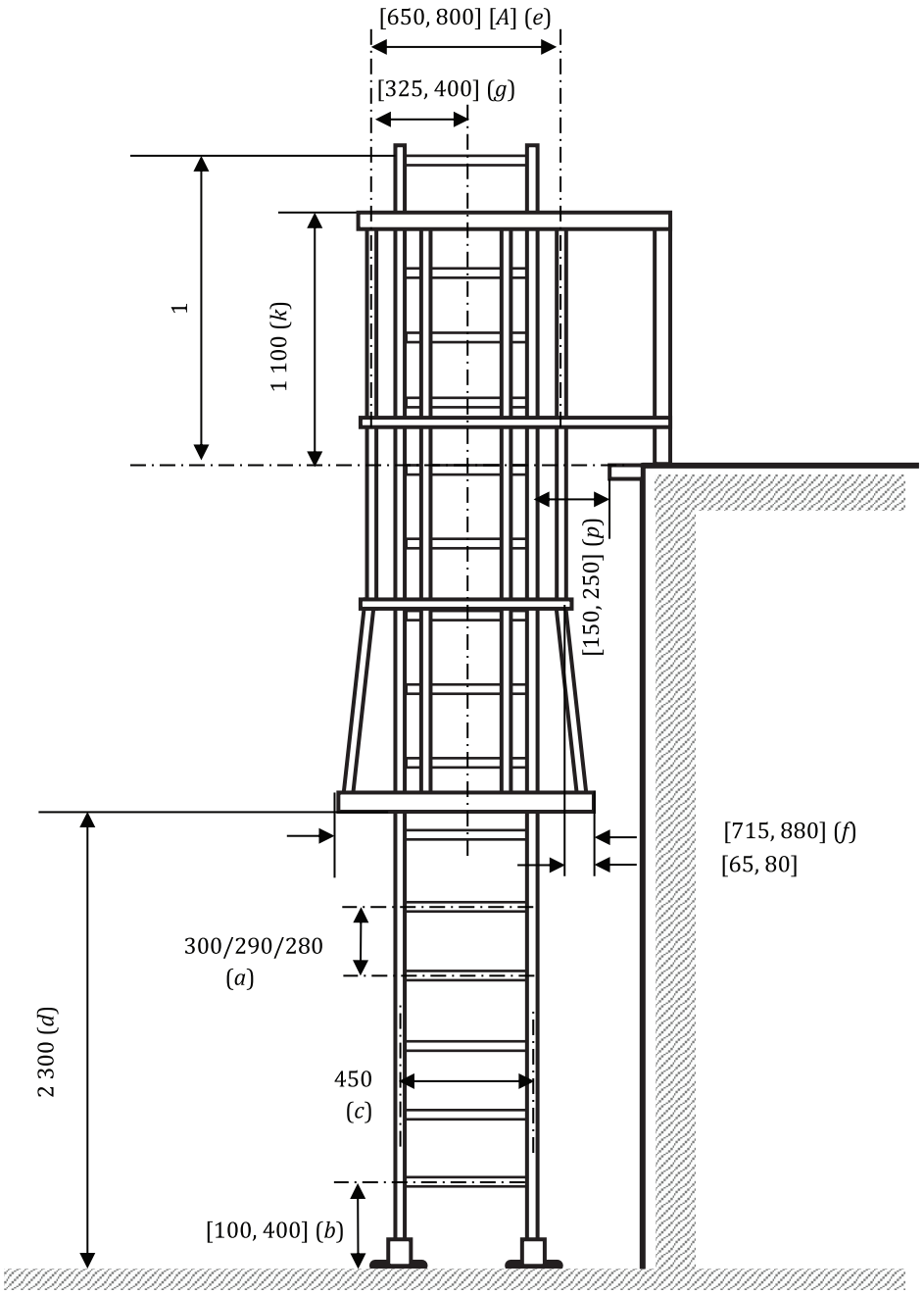
The rung of the ladder closest to the upper departure level shall be flush with the deck surface.

At the top of vertical ladders, self-closing gates shall be installed. The width between the stiles (stringer) at the top of the step-through ladder shall be the same width as the width of the safety gate.

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Dimension in millimetres



Key

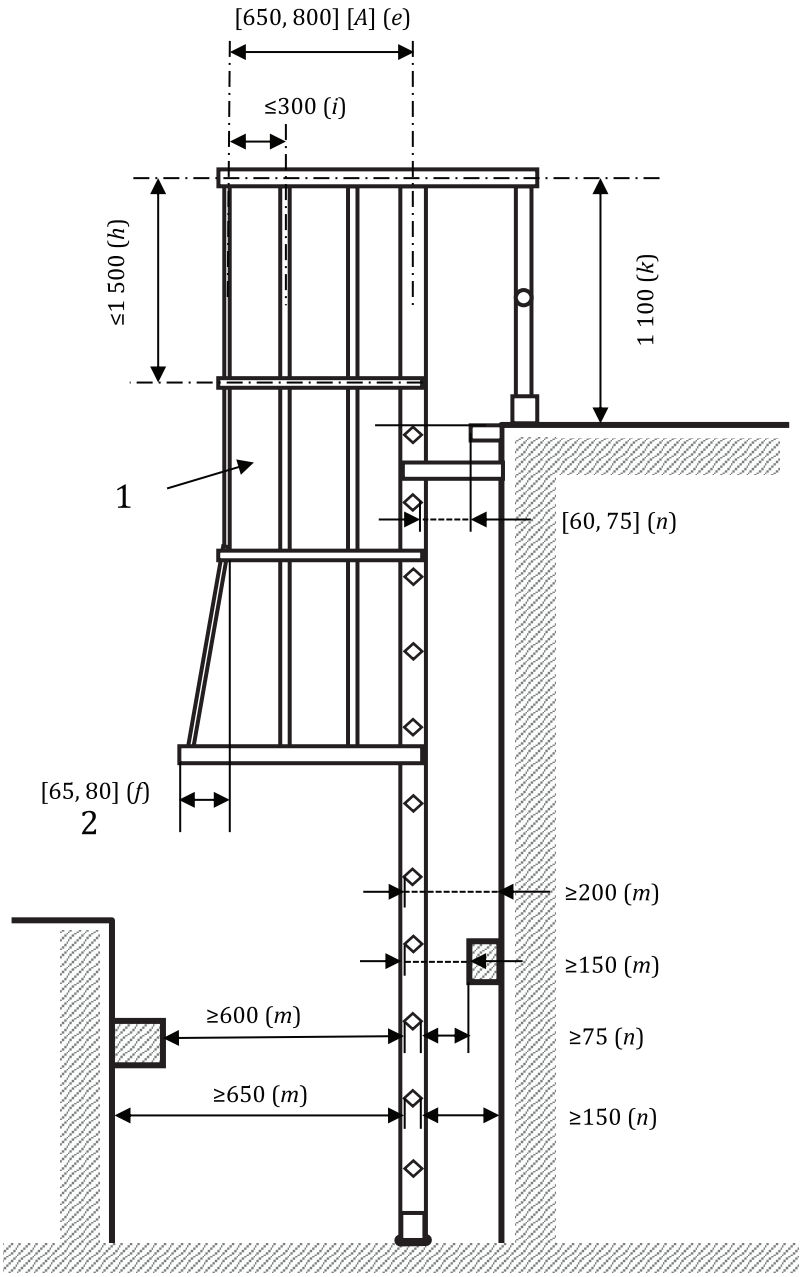
1 five (5) rungs (k): (300/290/280 × 5)
a spacing between successive rungs
b spacing between the lowest rung and the departure area
c width of ladder
d location of the lowest part of safety cage
e clear distance within safety cage hoop
f clear distance within the lowest part of safety cage hoop
g horizontal distance from the surrounding structure (safety cage) to centreline of ladder
p distance between the side access ladder stile and landing platform in the case of side access

Figure 16 — Specification for vertical ladders (side access ladder)

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Dimension in millimetres



Key

1 opening space (*j*)
2 max. 10 % of *A*
e clear distance within safety cage hoop
f clear distance within the lowest part of safety cage hoop
h vertical distance between two hoops of safety cage
i distance between two uprights of safety cage
k extension from arrival area
m space between the ladder and any permanent obstruction (measured from the front of the rungs)
n toe clearance space between the walk-through ladder and any permanent obstruction (measured from behind of the rungs)

Figure 17 — Specification for vertical ladders (walk-through ladders)

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4.6.3 Stiles (stringer)

The stiles shall be fixed at platform of departure area and upper level of arrival landing platform.

Intermediate support shall be provided when the height is under following conditions.

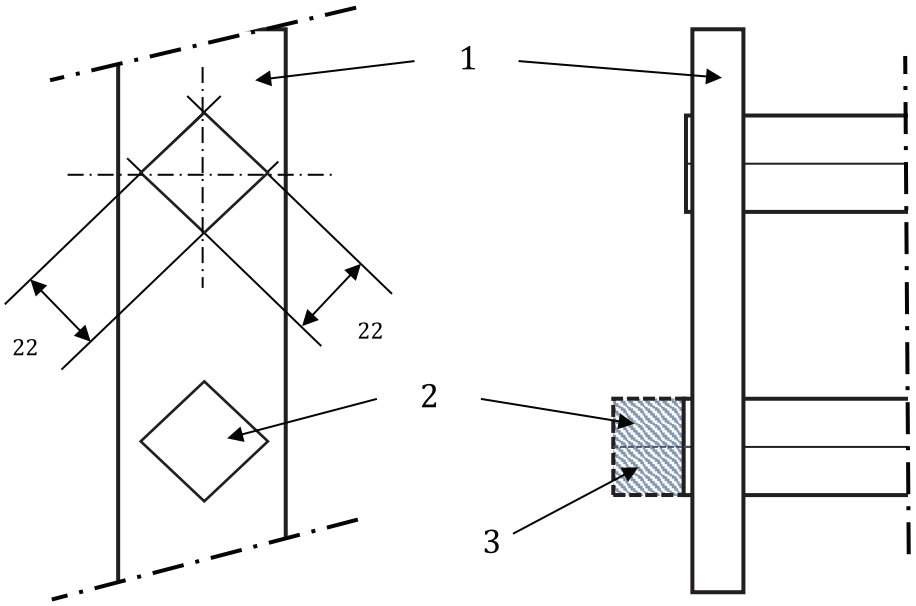
— When height > 3 000 mm with flat bar type stiles, minimum one intermediate support shall be provided for every 3 000 mm.

— When height > 5 000 mm with pipe type stiles, minimum one intermediate support shall be provided for every 5 000 mm.

4.6.4 Rungs

The shape specification is diamond type square as shown in Figure 18. Rung dimension specification is 22 mm for each side. The rungs shall be positioned in centre of the stile. The rung shall not extend after the penetration of the stile. Both sides of the stiles shall be continuously welded without any sharp edges.

Dimension in millimetres



Key

1 stile (stringer)
2 rung
3 penetrated part of rung shall be removed and continuously welded

Figure 18 — Specification for position, shape and penetration of rungs

4.6.5 Spacing between the ladder and any permanent obstruction

The space between the ladder and any permanent obstruction or obstacle shall be as follows.

a) Measured from the front of the rungs:

1) In front of the ladder: minimum 650 mm or, where obstacles such as pipes or trays cross, 600 mm.

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2) Behind the ladder: minimum 200 mm or where obstacles such as pipes or trays cross, 150 mm.

b) Measured from behind of the rungs:

1) Behind the ladder: minimum 75 mm, except the upper rung, which shall be between 60 mm and 75 mm for walk through ladders.

For side access ladder, the space between stiles and end of arrival area shall be between 150 mm and 250 mm to prevent tripping and falling hazard.

4.6.6 Fall protection device

When a safety cage is arranged, the distance between two hoops (vertical opening) shall not exceed 1 500 mm and the distance between two uprights (horizontal opening) shall not exceed 300 mm. The opening space of the safety cage shall not exceed 0,4 m^2 to prevent falling hazard.

The clear distances within the hoop of the safety cage shall be between 650 mm and 800 mm (see Figure 18). The distances should be decided based on a body size of 95th percentile male operator. For easy access, clearing distance for the lowest part of safety cage hoop is recommended to be expanded to maximum 10 % of the clearing distances to other part of the safety cage hoop (see Figure 19).

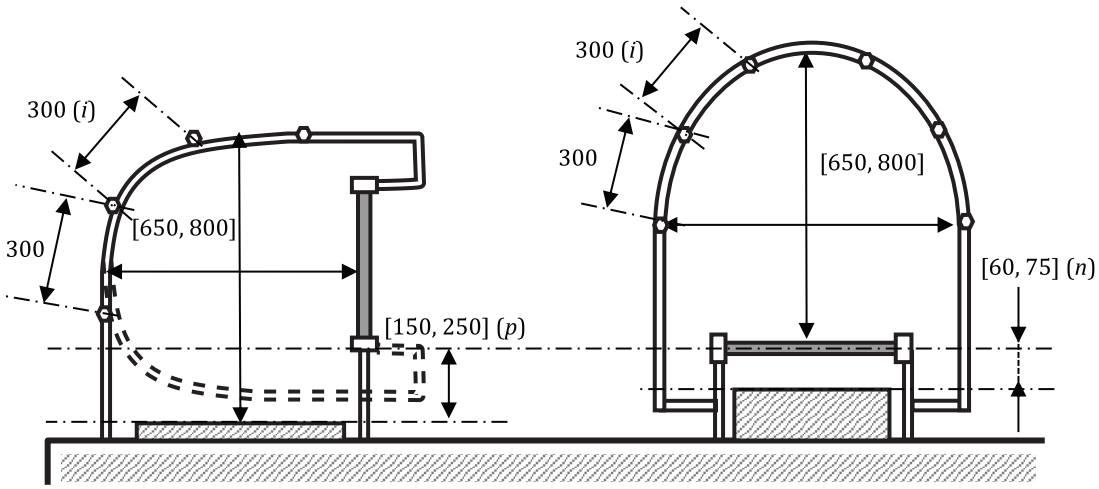
The height of the lowest part of safety cage hoop shall be between 2 200 mm and 2 500 mm. The recommended height is 2 300 mm.

The safety cage shall be extended at least same height as handrail from the arrival area.

If the horizontal distance from the fixed ladder, equipped with the safety case, to the guard-rail of an elevated departure area is more than 1 500 mm, the gaps inside the guard-rail shall be closed in the area left and right of the axis of the safety cage of 1 500 mm.

Two types of fall protection meshed structure are specified (see Figure 20). The types can be chosen by designer and/or operators to suit the situation of areas. The fall protection meshed structure shall be in accordance with ISO 14122-4.

Dimension in millimetres



a) Side access type **b) Walk-through type**

Key

i distance between two uprights of safety cage

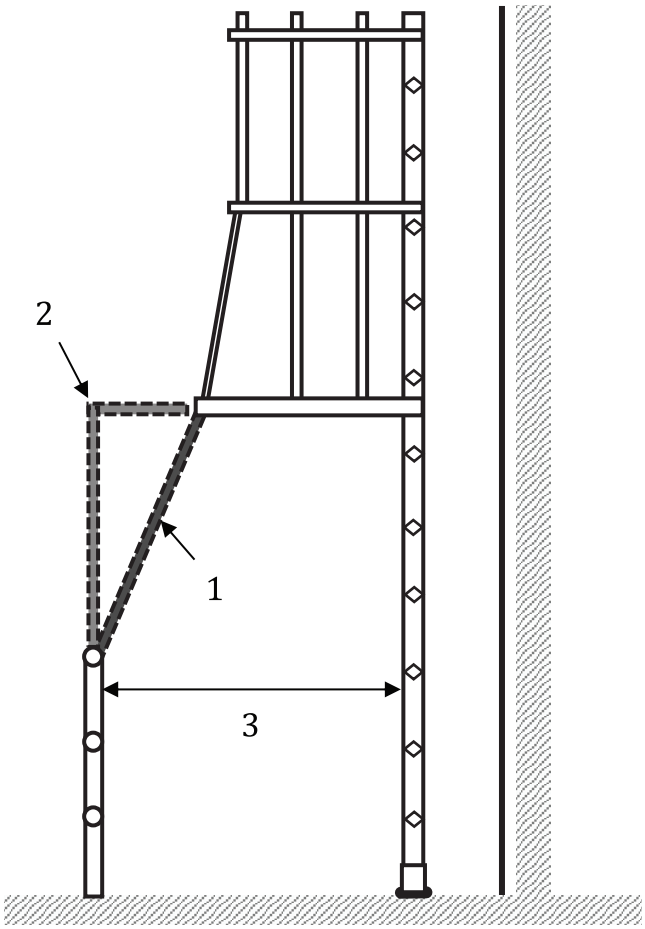
n toe clearance space between the walk-through ladder and any permanent obstruction

p distance between the side access ladder stile and landing platform in the case of side access

Figure 19 — Specification for shape of safety cage

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Key

1 fall protection meshed structure (type A)
2 fall protection meshed structure (type B)
3 when ≤ 1 500 mm

Figure 20 — Specification for protection bar

4.6.7 Structure requirements

The structure shall conform to the general requirements in ISO 14122-4.

4.6.8 Tests of vertical ladders

The test shall conform to the requirement of test procedure as described in Clause 10.

4.7 Grating

4.7.1 General

The design of the gratings shall conform to the requirements in Table 8; and the specifications should be consistently applied.

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Table 8 — Specification and requirements for gratings

Parameter	Specification	Requirement(s)	Comments and limitations
Opening diameter (Ball dropping test)	— 20 mm (above places where personnel can be present) — 35 mm (other areas where people normally should not be present)	— Max. 20 mm (above places where personnel can be present) — Max. 35 mm (other areas where people normally should not be present)	Deviation with NMA No. 856: Max. 15 mm
Bearing bar spacing (*a*)	— 20 mm (above places where personnel can be present) — 35 mm (other areas where people normally should not be present)	— Max. 20 mm (above places where personnel can be present) — Max. 35 mm (other areas where people normally should not be present)	Centre-to-centre distance
Cross bar spacing (*b*)	— 100 mm — 50 mm to 100 mm for leftmost and rightmost of cross bar	— 100 mm — 50 mm to 100 mm for leftmost and rightmost of cross bar	Centre-to-centre distance
Surface finish	— Non-slip: ex. punched type, Serrated type or equivalent — 3 mm depth — Radius: R 3,5 — Pitch: 12,5 mm	— Non-slip: ex. punched type, Serrated type or equivalent	
Height of toe plate for cut out by penetration of obstruction	— 100 mm — Min. 50 mm (under obstruction)	— Min. 100 mm — Min. 50 mm (under obstruction)	
Thickness of toe plate	— 8 mm	— 6 mm to 10 mm	
Opening between obstruction and grating	— Max. 50 mm	— Max. 50 mm	

4.7.2 General requirements

The grating is configured as shown in the Figure 21.

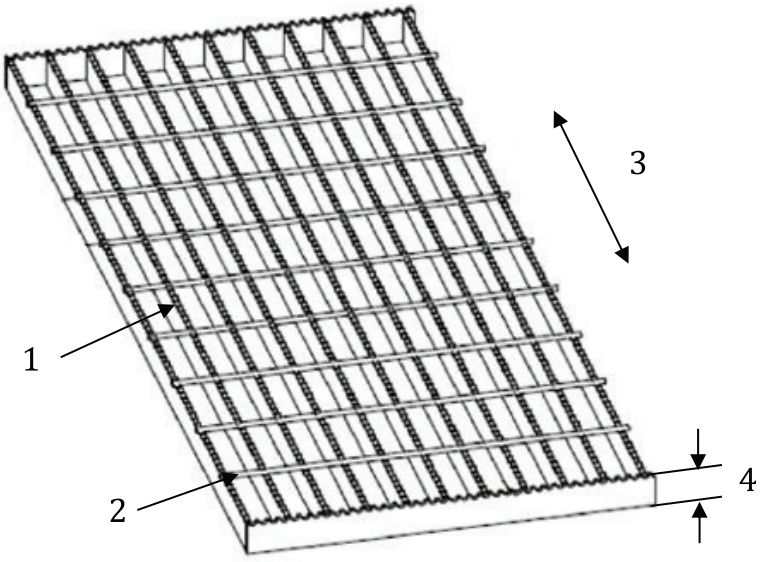
The main function of gratings is to provide safe access, non-skid walking surface and to prevent dropped objects. The requirements for grating apply to access ways for personnel and may not apply for grating to be used in areas for material handling and laydown.

Edges of grating shall be banded with the same thickness as a bearing bar.

The surface of the grating should be non-slip type such as punched, serrated or equivalent to prevent slipping hazard as shown in Figure 22.

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Key

1 serrated load bearing bars
2 distribution bars
3 span (direction of load bearing bars)
4 bearing/binding bar depth

Figure 21 — Grating components definition

Dimension in millimetres

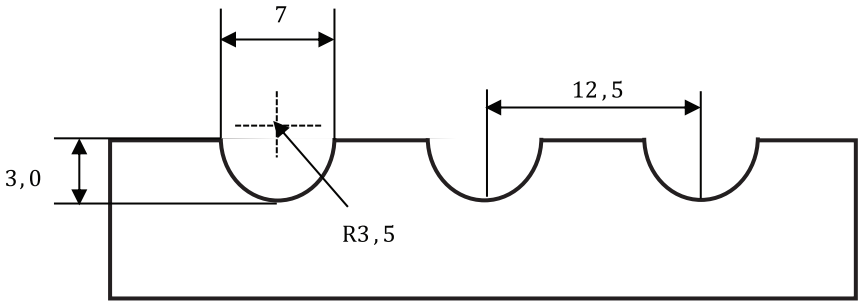


Figure 22 — Surface finish specification for gratings

4.7.3 Grating openings

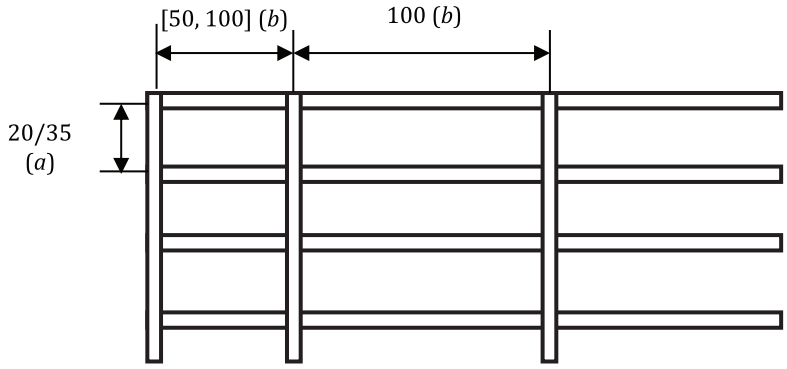
The grating on the floorings above a place where people are working, as opposed to occasional passage shall not allow a ball with a diameter of 20 mm to pass through. The grating in other areas shall not allow a ball with a diameter of 35 mm to pass through.

The spacing between bearing bars should be 20 mm or 35 mm and space between cross bar should be 100 mm to fulfil the ball dropping test. The space between cross bars in leftmost and rightmost can be between 50 mm and 100 mm (see Figure 23).

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Dimension in millimetres



Key

a bearing bar spacing

b cross bar spacing

Figure 23 — Specification for gratings

4.7.4 Penetrations

If pipe penetrates though the grating, a toe-plate with 100 mm height shall be provided around the pipe. If, because of an obstruction (see Figure 24), there is insufficient space for a full height toe-plate, the height of the toe-plate can be locally reduced to a minimum of 50 mm.

Dimension in millimetres

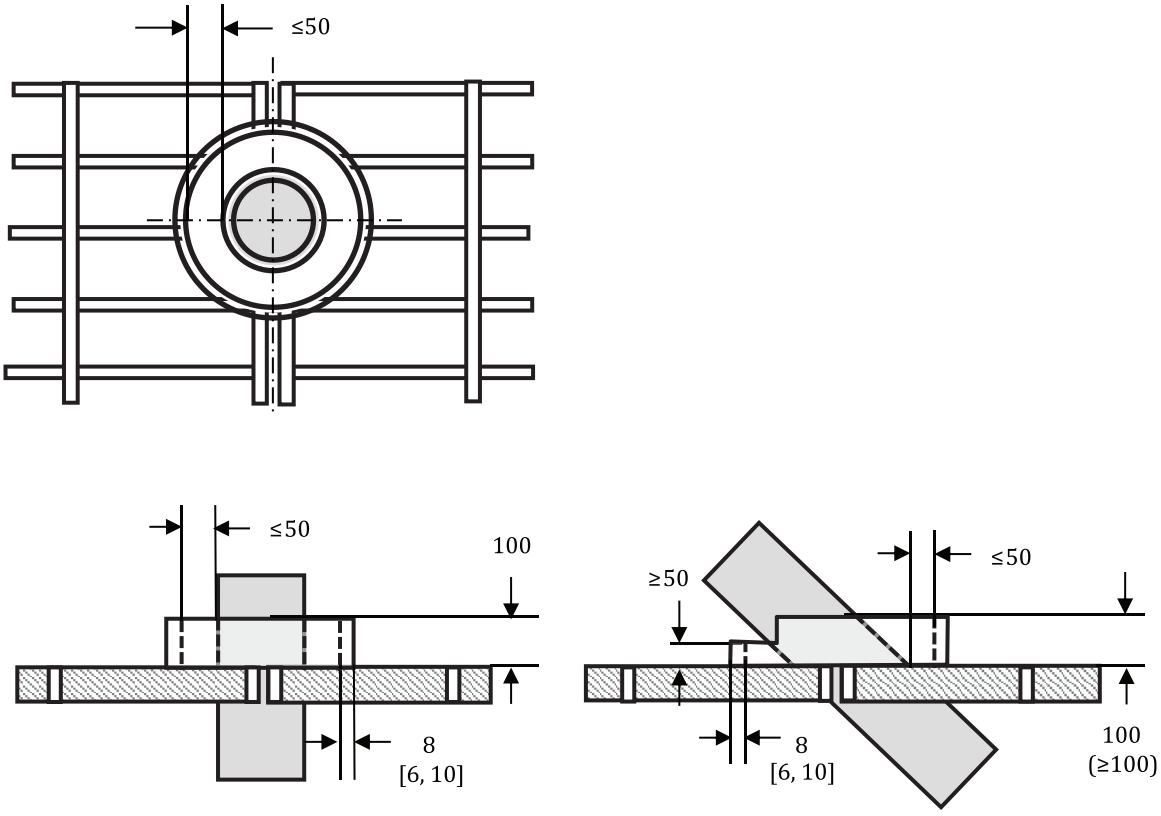


Figure 24 — Specification for penetration for gratings

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4.7.5 Tests of gratings

The test shall conform to the requirement of test procedure as described in Clause 10.

4.8 Access hole (manhole)

4.8.1 General

In the offshore industry, a access hole (manhole) has various design options, material specifications and dimensions. A code system for the design of access holes (manholes) is frequently used. This document recommends using design options, material specifications and dimensions for man holes through a unified code system as shown in Figure 25.

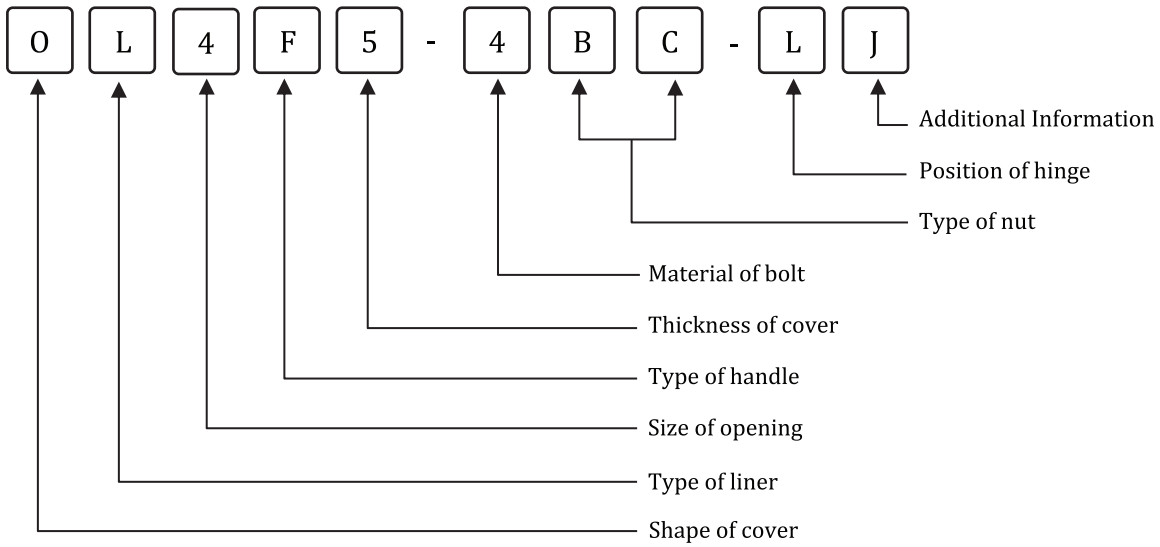


Figure 25 — Unified code specification for access hole (manhole)

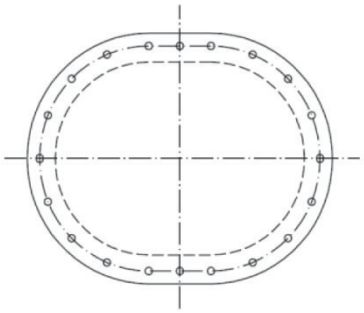
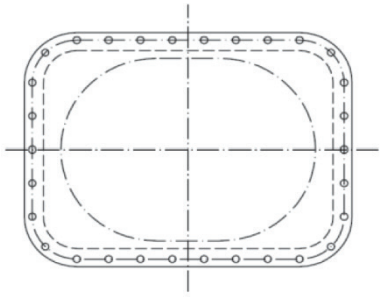
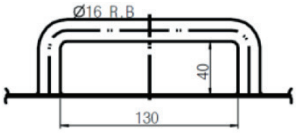
Access hole (manhole) code components are described in Table 9 and design details are given in Annex C.

Typical drawing examples are given in Annex D as practical drawings.

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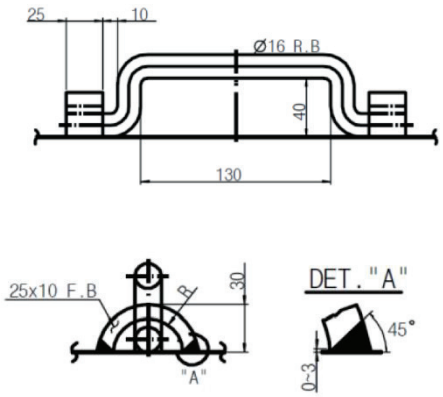
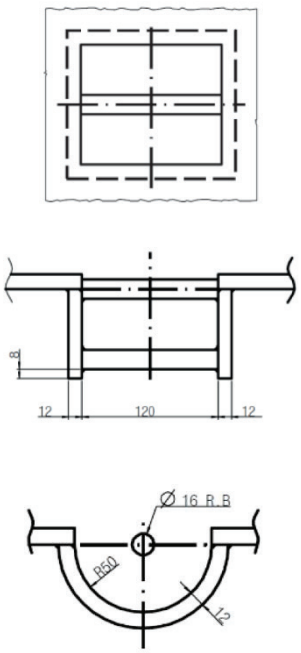
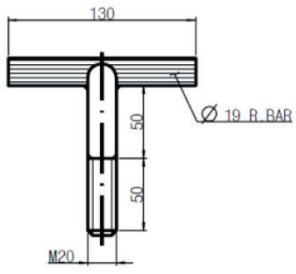
Table 9 — Code details

Part	Code	Description	Shape	Comment
Shape of cover	**O**	Oval		
	S	Square		
Type of liner	**L**	Liner		
	C	Coaming		
	F	Flush		
	R	Recess		
Size of opening	**4**	400 × 600		
	5	500 × 700		
	6	600 × 800		
	S	Special size		
	F	Fixed	 	

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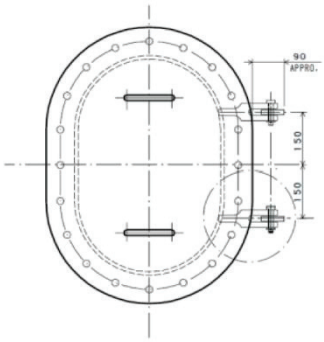
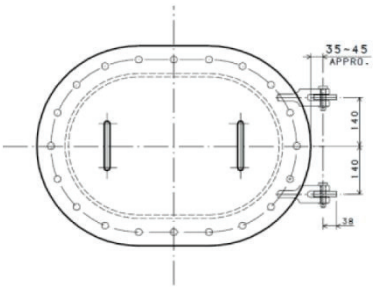
Table 9 *(continued)*

Part	Code	Description	Shape	Comment
Type of handle	**H**	Hinged		Foldable type
	R	Recessed		
	T	T-bolt		
	N	Non-handle		
Thickness of cover	**2**	12,0		Recommended
	5	15,0		
	8	18,0		
Material of bolt	**4**	Stainless steel		SS304 or SUS304
	6	Stainless steel		Recommended SS316 or SUS316

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Table 9 *(continued)*

Part	Code	Description	Shape	Comment
Type of nut	**BC**	Brass cap		
	BH	Brass hexagon		
	SC	Stainless steel cap		
	SH	Stainless steel hexagon		
	SH6	Stainless steel hexagon		SS316 or SUS316
Position of hinge	**L**	Long axis		
	S	Short axis		
Additional Information	**N**	No additional information		
	J	Jack up bolt		
	W	washer		
	G	Gas tight cover		
	P	Special packing		

4.9 Connection method

4.9.1 General

The connection method for steel outfitting shall consider self-loosening prevention, suitable fastening and maintainability.

4.9.2 Selection connection method for steel outfitting

Bolt and nut as fastening method should be used with specification for bolt and nuts in Table 10.

Mechanical properties of bolt, nut and washers shall be in accordance with ISO 898-1, ISO 898-2 and ISO 898-3.

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Table 10 — Specification for bolt and nuts

Item	Bolt type	Thread diameter	Nut and washer
Handrail	Normal hexagon head bolt	M12	Two nuts One plain washer
Removal hand-rail	Normal hexagon head bolt	M12	Two nuts One plain washer
Clamp	Normal hexagon head bolt	M12	One nut [a] One plain washer
Ladder	Normal hexagon head bolt	M16	Two nuts One plain washer
	J-bolt	M12	Two nut One plain washer

[a] Two nuts are recommended if there is vibration or the frequency of removal is low.

Normal hexagon head bolt and J bolt can be used for fastening between bottom of ladder and grating. The curvature radius of the J bolt head shall consider the spacing between the bearing bars to ensure a tight fit (see Figure 26).



a) Normal hexagon head bolt **b) J bolt on grating**

Figure 26 — Bolt fasting between ladder and grating

4.9.3 Self-loosening prevention

Double nut system (regular and thin nuts) should be used to prevent self-loosening where vibration occurs. The reason why the double nut system is effective in resisting self-loosening is due to the way the threads are jammed together. Since the bolt thread is in contact with the top flank of the small nut and the bottom flank of the top nut, relative thread movement is not possible.

Thin nuts used as jam nuts shall be assembled together with a regular nut or a high nut. In assemblies with jam nut, the thin nut is first tightened against the assembled parts and then the regular or high nut is tightened against the thin nut (see Figure 27).

4.9.4 Nuts fastening

The nuts should be fastened for preventing self-loosening according to following steps.

a) The thin nut should be placed on the bolt first.

b) The thin nut shall be tightened to between 25 % to 50 % of the overall tightening torque.

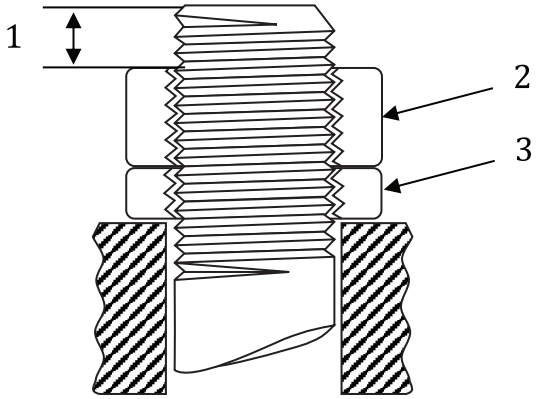
c) The second (regular or high) nut is then placed on the bolt.

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d) The thin nut held to prevent rotation by a spanner whilst the thick nut is tightened to the full torque value.

Minimum fine three (3) pitch threads shall be protruding beyond the top of the nuts after fastening. The bolt length shall be considered with the protruding pitch threads.



Key

1 min. 3 pitch threads
2 regular nut
3 thin nut

Figure 27 — Specification for nuts

The nut shall resist the proof load specified in ISO 898-2 without fracture by thread stripping or nut fracture.

The nut shall be removable using the fingers after the release of the proof load (and, if necessary, after a half turn maximum with a wrench).

4.9.5 Height of nut

The requirements for three styles of nuts according to their height (see ISO 898-2):

— style 1: regular nut with minimum height $m_{min} \geq 0{,}8D$;

— style 0: thin nut with minimum height $0{,}45D \leq m_{min} < 0{,}8D$.

where

D is nominal thread diameter of the nut;

m_{min} is minimum height of the nut.

The height of the thin nut shall be within the following ranges, considering the height of the regular nut.

$$0{,}5 \times H_{reg} < H_{thin} < 0{,}8 \times H_{reg}$$

where

H_{reg} is height of regular nut;

H_{thin} is height of thin nut.

4.9.6 Grating fastener

The fastener for grating shall be ensured to be prevented moving of the gratings. The fastener shall be stainless steel material.

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