Guidelines for the Design of the Means of Access for Inspection, Maintenance and Operation of Commercial Ships

April 2008

Guidance Note
NI 537 DT R00 E

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MARINE DIVISION
GENERAL CONDITIONS

ARTICLE 1

1.1. - BUREAU VERITAS is a Society the purpose of whose Marine Division (the "Society") is the classification ("Classification") of any ship or vessel or structure of any type or part of it or system therein collectively hereinafter referred to as a "Unit" whether linked to shore, river bed or sea bed or not, whether operated or located at sea or in inland waters or partly on land, including submarines, hovercrafts, drilling rigs, offshore installations of any type and of any purpose, their related and ancillary equipment, subsea or not, such as well head and pipelines, mooring legs and mooring points or otherwise as decided by the Society.
The Society:

- prepares and publishes Rules for classification, Guidance Notes and other documents ("Rules");
- issues Certificates, Attestations and Reports following its interventions ("Certificates");
- publishes Registers.

1.2. - The Society also participates in the application of National and International Regulations or Standards, in particular by delegation from different Governments. Those activities are hereafter collectively referred to as "Certification".

1.3. - The Society can also provide services related to Classification and Certification such as ship and company safety management certification; ship and port security certification, training activities; all activities and duties incidental thereto such as documentation on any supporting means, software, instrumentation, measurements, tests and trials on board.

1.4. - The interventions mentioned in 1.1., 1.2. and 1.3. are referred to as "Services". The party and/or its representative requesting the services is hereinafter referred to as the "Client". **The Services are prepared and carried out on the assumption that the Clients are aware of the International Maritime and/or Offshore Industry (the "Industry") practices.**

1.5. - The Society is neither and may not be considered as an Underwriter, Broker in ship's sale or chartering, Expert in Unit's valuation, Consulting Engineer, Controller, Naval Architect, Manufacturer, Shipbuilder, Repair yard, Charterer or Shipowner who are not relieved of any of their expressed or implied obligations by the interventions of the Society.

ARTICLE 2

2.1. - Classification is the appraisement given by the Society for its Client, at a certain date, following surveys by its Surveyors along the lines specified in Articles 3 and 4 hereafter on the level of compliance of a Unit to its Rules or part of them. This appraisement is represented by a class entered on the Certificates and periodically transcribed in the Society's Register.

2.2. - Certification is carried out by the Society along the same lines as set out in Articles 3 and 4 hereafter and with reference to the applicable National and International Regulations or Standards.

2.3. - **It is incumbent upon the Client to maintain the condition of the Unit after surveys, to present the Unit for surveys and to inform the Society without delay of circumstances which may affect the given appraisement or cause to modify its scope.**

2.4. - The Client is to give to the Society all access and information necessary for the performance of the requested Services.

ARTICLE 3

3.1. - The Rules, procedures and instructions of the Society take into account at the date of their preparation the state of currently available and proven technical knowledge of the Industry. They are not a code of construction neither a guide for maintenance or a safety handbook.

Committees consisting of personalities from the Industry contribute to the development of those documents.

3.2. - The Society only is qualified to apply its Rules and to interpret them. Any reference to them has no effect unless it involves the Society's intervention.

3.3. - The Services of the Society are carried out by professional Surveyors according to the Code of Ethics of the Members of the International Association of Classification Societies (IACS).

3.4. - The operations of the Society in providing its Services are exclusively conducted by way of random inspections and do not in any circumstances involve monitoring or exhaustive verification.

ARTICLE 4

4.1. - The Society, acting by reference to its Rules:

- reviews the construction arrangements of the Units as shown on the documents presented by the Client;
- conducts surveys at the place of their construction;
- classes Units and enters their class in its Register;
- surveys periodically the Units in service to note that the requirements for the maintenance of class are met.

The Client is to inform the Society without delay of circumstances which may cause the date or the extent of the surveys to be changed.

ARTICLE 5

5.1. - The Society acts as a provider of services. This cannot be construed as an obligation bearing on the Society to obtain a result or as a warranty.

5.2. - The certificates issued by the Society pursuant to 5.1. here above are a statement on the level of compliance of the Unit to its Rules or to the documents of reference for the Services provided for.

In particular, the Society does not engage in any work relating to the design, building, production or repair checks, neither in the operation of the Units or in their trade, neither in any advisory services, and cannot be held liable on those accounts. Its certificates cannot be construed as an implied or express warranty of safety, fitness for the purpose, seaworthiness of the Unit or of its value for sale, insurance or chartering.

5.3. - The Society does not declare the acceptance or commissioning of a Unit, nor of its construction in conformity with its design, that being the exclusive responsibility of its owner or builder, respectively.

5.4. - The Services of the Society cannot create any obligation bearing on the Society or constitute any warranty of proper operation, beyond any representation set forth in the Rules, of any Unit, equipment or machinery, computer software of any sort or other comparable concepts that has been subject to any survey by the Society.

ARTICLE 6

6.1. - The Society accepts no responsibility for the use of information related to its Services which was not provided for the purpose by the Society or with its assistance.

6.2. - If the Services of the Society cause to the Client a damage which is proved to be the direct and reasonably foreseeable consequence of an error or omission of the Society, its liability towards the Client is limited to ten times the amount of fee paid for the Service having caused the damage, provided however that this limit shall be subject to a minimum of eight thousand (8,000) Euro, and to a maximum which is the greater of eight hundred thousand (800,000) Euro and one and a half times the above mentioned fee.

The Society bears no liability for indirect or consequential loss such as e.g. loss of revenue, loss of profit, loss of production, loss relative to other contracts and indemnities for termination of other agreements.

6.3. - All claims are to be presented to the Society in writing within three months of the date when the Services were supplied or (if later) the date when the events which are relied on of were first known to the Client, and any claim which is not so presented shall be deemed waived and absolutely barred.

ARTICLE 7

7.1. - Requests for Services are to be in writing.

7.2. - Either the Client or the Society can terminate as of right the requested Services after giving the other party thirty days' written notice, for convenience, and without prejudice to the provisions in Article 8 hereunder.

7.3. - The class granted to the concerned Units and the previously issued certificates remain valid until the date of effect of the notice issued according to 7.2. hereabove subject to compliance with 2.3. hereabove and Article 8 hereunder.

ARTICLE 8

8.1. - The Services of the Society, whether completed or not, involve the payment of fee upon receipt of the invoice and the reimbursement of the expenses incurred.

8.2. - Overdue amounts are increased as of right by interest in accordance with the applicable legislation.

8.3. - The class of a Unit may be suspended in the event of non-payment of fee after a first unfruitful notification to pay.

ARTICLE 9

9.1. - The documents and data provided to or prepared by the Society for its Services, and the information available to the Society, are treated as confidential. However:

- Clients have access to the data they have provided to the Society and, during the period of classification of the Unit for them, to the **classification file** consisting of survey reports and certificates which have been prepared at any time by the Society for the classification of the Unit ;
- copy of the documents made available for the classification of the Unit and of available survey reports can be handed over to another Classification Society Member of the International Association of Classification Societies (IACS) in case of the Unit's transfer of class;
- the data relative to the evolution of the Register, to the class suspension and to the survey status of the Units are passed on to IACS according to the association working rules;
- the certificates, documents and information relative to the Units classed with the Society may be reviewed during IACS audits and are disclosed upon order of the concerned governmental or inter-governmental authorities or of a Court having jurisdiction.

The documents and data are subject to a file management plan.

ARTICLE 10

10.1. - Any delay or shortcoming in the performance of its Services by the Society arising from an event not reasonably foreseeable by or beyond the control of the Society shall be deemed not to be a breach of contract.

ARTICLE 11

11.1. - In case of diverging opinions during surveys between the Client and the Society's surveyor, the Society may designate another of its surveyors at the request of the Client.

11.2. - Disagreements of a technical nature between the Client and the Society can be submitted by the Society to the advice of its Marine Advisory Committee.

ARTICLE 12

12.1. - Disputes over the Services carried out by delegation of Governments are assessed within the framework of the applicable agreements with the States, international Conventions and national rules.

12.2. - Disputes arising out of the payment of the Society's invoices by the Client are submitted to the Court of Nanterre, France.

12.3. - Other disputes over the present General Conditions or over the Services of the Society are exclusively submitted to arbitration, by three arbitrators, in London according to the Arbitration Act 1996 or any statutory modification or re-enactment thereof. The contract between the Society and the Client shall be governed by English law.

ARTICLE 13

13.1. - These General Conditions constitute the sole contractual obligations binding together the Society and the Client, to the exclusion of all other representation, statements, terms, conditions whether express or implied. They may be varied in writing by mutual agreement.

13.2. - The invalidity of one or more stipulations of the present General Conditions does not affect the validity of the remaining provisions.

13.3. - The definitions herein take precedence over any definitions serving the same purpose which may appear in other documents issued by the Society.

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Introduction and history of the guidelines

These guidelines aim to provide detailed information on the design features that should be included, when considering the means of access of a ship, in order to reduce the risk of slips, trips and falls. In 2004 the International Maritime Organisation adopted amendments to SOLAS Reg.II-1/3-6 on technical provisions for access to and within spaces in and forward of the cargo area oil tankers and bulk carriers [Resolution MSC.151 (78)] and amendments to the Technical provisions for means of access for inspections (Resolution MSC.158 (78)], for entry into force on 1st January 2006.

In response to this, IACS published Unified Interpretations, namely IACS UI SC 191 for the application of amended SOLAS Regulation II-1/3-6 and revised Technical Provisions for means of access for inspections. Thus, these interpretations provide technical specifications with particular dimensional requirements for ensuring the safe access of the different compartments of oil tankers and bulk carriers.

However, these interpretations sometimes remain too general and do not cover the spectrum of issues one can face when using the means of access. Moreover, they only deal with oil tankers and bulk carriers although the other types of ships should also be provided with safe means of access.

Therefore, Bureau Veritas developed these guidelines to help those involved in the design of ships ensure that the means of access for inspection, maintenance and operation are safe and effective. The guidelines set out the ergonomic standards that will ensure that all users of the ship from seafarers to part time users such as shipyard workers and surveyors, can safely access the ship's compartments.

The objective of these guidelines is not to replace the existing regulatory requirements for the design of the means of access: it does not provide interpretations of the IMO regulations and technical provisions, nor of the IACS unified interpretations. On the contrary, it provides designers and ship owners who wish to go further in the prevention of occupational accidents with a means to do so. Furthermore, while the IMO definition of means of access is restricted to those used for inspection, in this document this phrase describes the means of access for inspection, maintenance and operation of the ship as well.

1. The method

The method employed to develop guidelines relies on two fundamental ideas:

1. When designing the workplace, high consideration has to be given to fitting the product to the user and the task they have to complete. In this case, fitting the ship or more precisely the permanent means of access, to the seafarer whose duties include maintenance, ship operation and emergency evacuation.

2. If the designers want the product to fit the user and the task, they have to integrate relevant user-feedback in the design process.

In this respect, the requirements presented in the guidelines result from on one hand, feedback from experienced surveyors as well as shipboard observations and, on the other hand, ergonomic analysis of the means of access.

1.1. User feedback

User feedback techniques allow to gather a substantial amount of information from the people operating the ships in order to focus on the most relevant and practical issues that arise from the Means of Access (MAs) onboard. Thus, instead of making assumptions about the suitability and riskiness of the MAs, it is aimed to confront opinions from the different users. For this purpose, three different tools to get the most complete feedback as possible are used. These are:

- Free and semi-structured interviews;
- Personal visit to ships; and
- Questionnaires.

The first two tools provide some qualitative data whereas the questionnaires allow a quantitative analysis to be completed.

1.2. An ergonomic approach: anthropometric analysis of the Means of Access (MAs)

1.2.1. Ergonomics

There are five fundamental criteria in ergonomics theory that ensure a successful match of the product, the user and the task [Pheasant, 2006]. These are:

- Man-machine interface (e.g. functional efficiency);
- Ease of use;
- Comfort;
- Health and safety and;
- Quality of working life.

In order to ensure the guidelines, and therefore any design that follows them, comply with these criteria, the principles of the user-centred design are employed.

User-centred design should:

- Be empirical and iterative;
- Be participative (end users are active participants);
- Take into account human diversity;
- Be system-oriented;
- Be pragmatic.

These guidelines are developed using anthropometric analysis that matches all the principles above.

1.2.2. Anthropometry

1.2.2.1. Definition

Anthropometry is the branch of ergonomics dealing with the measurement of the human body. Data is collected for the size, shape, strength, mobility and flexibility of different populations and genders. From the results of an anthropometric analysis, many of the technical requirements for the design of user-centred MAs onboard ships may be extracted.

According to Pheasant, the objective of anthropometrics is to choose the best compromise dimensions for equipment that will be employed by a range of users [Pheasant, 2006]. In order to optimize such compromises, three types of information are required:

- The anthropometric characteristics of the user population;
- The ways in which these characteristics might impose constraints upon design;
- The criteria that define an effective match between the product, the user and the task.

1.2.2.2. Anthropometric design

1.2.2.2.1. Population description

The population aimed at is mainly composed of seafarers. As the ships can be operated by crews of both sexes and coming from any region of the world, the complete international population of seafarers is studied.

Most anthropometric variables conform quite closely to the normal distribution (at least for reasonably homogeneous populations) [Pheasant 2006]. Thus, population

measurements are described with the percentiles of the distribution. For instance, for the measurement of men's stature, considering the limiting user as the tallest of the 95th percentile of the population implies that 5% of the population is taller than this man.

However, specific anthropometric data about the seagoing population is not available. Therefore, data for international populations are used. The anthropometric data use the fifth percentile Japanese woman for the 'lower' limiting users and the 99th percentile American man for the 'upper' limiting users.

The effect of clothes and equipment on the dimensions of members of the population is also considered. It is assumed that all of them wear protective boots, working clothes, gloves and a protective helmet. Furthermore, when this is required by the situation analysed, the seafarers are assumed to wear specific additional equipment such as breathing apparatus for the study of emergency scenarios.

1.2.2.2.2. Constraint definition

These guidelines are developed with the following constraints in mind:

- Clearance:

  The means of access must provide adequate access and circulation space. Handles must provide adequate apertures for the fingers or palm. These constraints are used to determine the minimum acceptable dimension.

- Reach:

  The means of access must be within reasonable proximity of the user. These dimensions are usually fitted to the smallest member of the population and they determine the maximum acceptable distances.

- Posture:

  When using the means of access user must be able to maintain a suitable posture. Postural problems tend to be more complex than problems of clearance and reach, since posture is almost certainly affected by more than one dimension of the means of access.

These constraints are then used to develop the guidelines. This process ensured the characteristics of the means of access are designed for the *limiting user* and a *defined area of common fit* is provided.

1.2.2.2.3. Environmental considerations

These guidelines take into consideration the environments in which the MAs are placed onboard vessels. It is essential to take into account the marine environment since it also determines the way MAs' design should be addressed, e.g. the corrosive atmosphere and the motions of the ship.

1.2.2.2.4. Scope of guidelines and means of access considered

These guidelines address the walkways, guardrails, handrails, platforms, vertical openings, horizontal openings, vertical ladders, and stair ladders or inclined ladders. These means of access are identified as covering the vast majority of slips trips and falls.

In addition to these MAs, general requirements and advice are offered on the marking of the means of access, slip resistance, training and maintenance.

1.2.2.2.5. Design strategies

Each type of means of access implies scenarios depending on the environmental conditions, the tasks to perform and the seafarers' physical characteristics (body measurements and strength). Thus, different design strategies have to be employed for these different scenarios. Below are examples of design strategies that are adopted in the development of these guidelines:

- For the walkways, tunnels and corridors:
    - Obstructions should be clearly visible and clearance around them should be sized for the largest user;
    - Width of passageways should be designed for the largest user;
    - Handrails, treads and guardrails should be designed for common fit.
    - Walkways, tunnels and corridors should be large enough to allow the evacuation of an injured crewmember on a stretcher.

- For the openings, hatches and manholes:
    - The vertical and horizontal openings should be designed for access of the largest user. People with dimensions higher than this percentile must be advised of this. A person wearing breathing apparatus should pass through easily;
    - The handles, treads, steps, guardrails and other arrangements for safe access to openings and hatches should be sized for common fit;
    - Markings of openings (especially horizontal openings) should be clearly visible;
    - The openings should be large enough to allow the evacuation of an injured crewmember on a stretcher.

- For the ladders, stairways and inclined ladders:

    - Design for the heaviest user to be able to climb;
    - Design platforms for the largest user;
    - Design for the smallest and the largest users to comfortable climb the rungs of a ladder;
    - The handles, treads, steps, handrails, guardrails and other arrangements for safe access to ladders should be sized for common fit.

1.2.2.3. Guidelines development stage

Considering the design strategies adopted and all the constraints and requirements identified, the objective is to find the best designs of MAs by trying to reproduce the real life working situations onboard. Multiple drawings used in order to model the interactions between the seafarers and the MAs. Four environments were modelled 3-dimensionally, grouping the four main types of MAs: walkways, openings, vertical ladders, and inclined ladders or stair ladders. 3-D manikins were used to calculate the dimensions and shapes of the MAs.

2. The Guidelines: requirements for the design and use of the Means of Access (MAs)

The guidelines are presented in this section and gather both dimensional requirements and practical advice for the design, use and maintenance of the MAs. The MAs are grouped by type.

However, some points have to be made clear to prevent the reader from misinterpreting the focus of these guidelines:

- These guidelines deal with ships in general, whatever their size or their type. They provide the shipbuilders and shipyards with some ergonomic requirements and advice that are not specific to determined areas. However, some remarks are made about the applicability of the requirements to specific parts of the ship.

- As specified in the introduction, these guidelines are not meant to describe how to apply the IMO regulations about the means of access for inspections and the unified interpretation from IACS. They complete these regulations by introducing the concepts of ergonomic/anthropometric design made to ensure safety and comfort of the personnel using the means of access.

- The technical requirements provided in these guidelines are based on purely ergonomic principles. Consequently they are not meant to replace neither structural requirements based on mechanics and hydrodynamics nor technological analysis.

2.1. Walkways, guardrails and handrails

This section focuses on the design of the walkways or passageways wherever they are situated. The requirements for the guardrails and handrails are also applicable to any of the rails onboard (the rails presented in the following sections should comply with these requirements as well).

Note: There is a distinction to be made between a handrail and a guardrail. The former is designed to help people keep their balance while walking (e.g. due to ship motions or obstacles), while the latter is designed to prevent people from falling from a height.

2.1.1. Walkways and platforms

2.1.1.1. General requirements for walkways

	Dimension	IMO-IACS requirements	Guidelines requirements
A	Distance below overhead structure	1600 mm ≤ A ≤ 3m	2020 mm ≤ A ≤3m
B	Ramp inclination angle	-	B ≤15°
C	Guardrail height (when one side at least of the passageway is open)	C = 1000 mm	C around 1200 mm

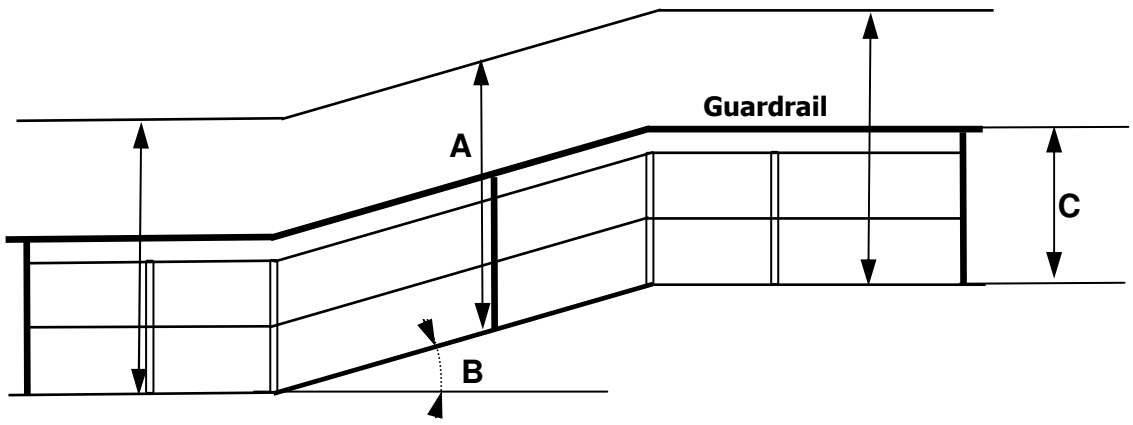


Figure 1: Requirements for walkways (general)

2.1.1.2. Requirements for walkways – clearance

	Dimension	IMO-IACS requirements	Guidelines requirements
A	Unobstructed width	A ≥ 600 mm	A ≥ 700 mm
B	Clearance height	-	B ≥ 1700 mm
C	Clearance width	-	C ≥ 600 mm
D	Sill height from bottom	-	D ≤ 150 mm

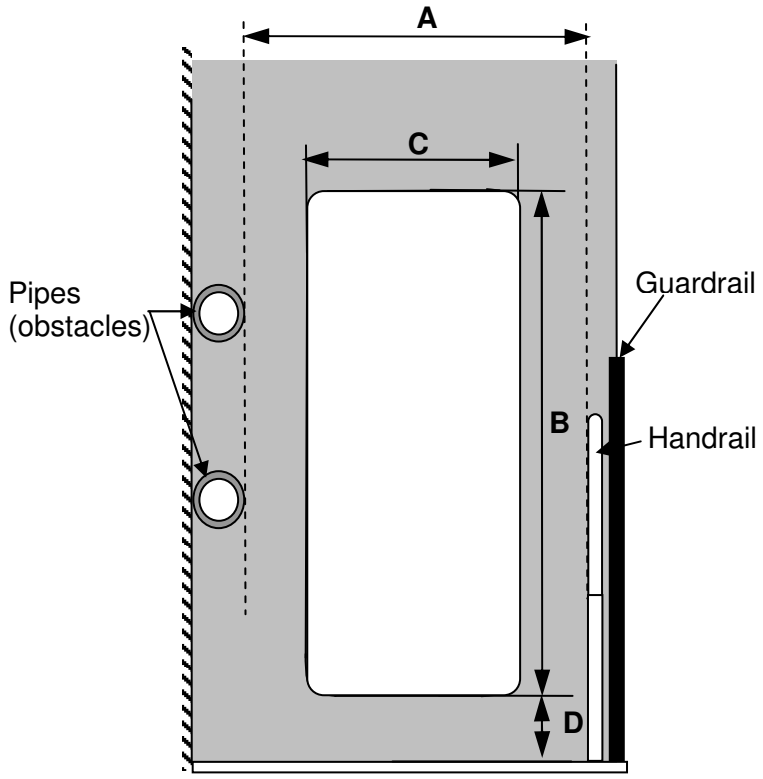


Figure 2: Requirements for walkways (clearance)

2.1.1.3. Requirements for walkways – around webframes

	Dimension	IMO-IACS requirements	Guidelines requirements
A	Width (for going around vertical webframe)	A ≥ 450 mm	A ≥ 600 mm
B	Handle length	-	B ≥ 600 mm

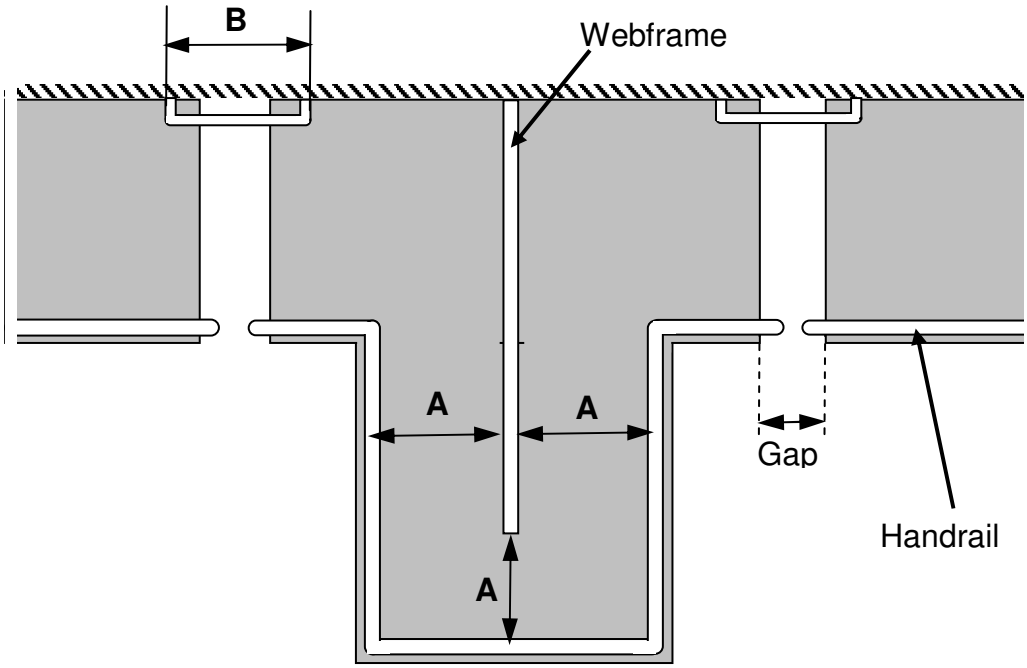


Figure 3: Requirements for walkways (webframes)

2.1.1.4. Requirements for low height structures

Some areas such as double bottom ballast tanks and specific places in fore and aft peaks cannot provide sufficient height for a standing inspection. However, a minimum height for overhead obstructions is required for crawling safely:

	Dimension	IMO-IACS requirements	Guidelines Requirements
A	Distance below overhead obstructions when crawling	-	A ≥ 1000 mm

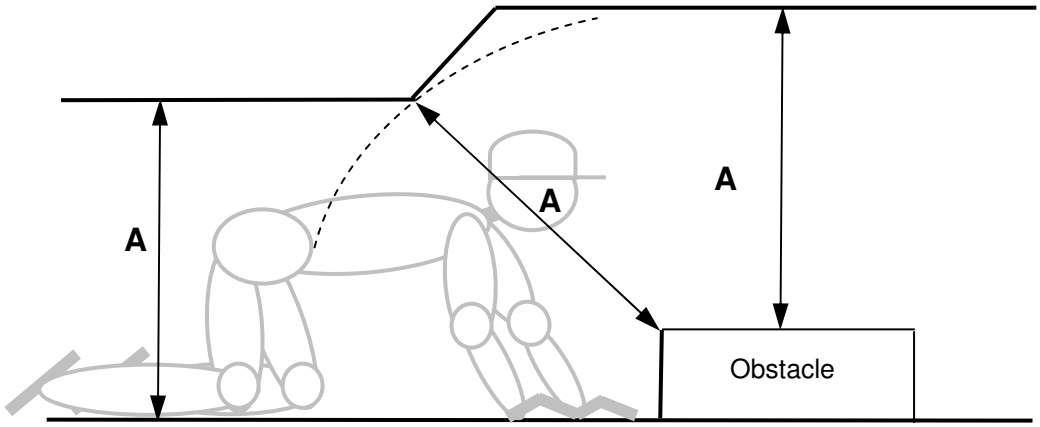


Figure 4: Requirements for low height structures

2.1.1.5. Requirements for handrails – 1

	Dimension	IMO-IACS requirements	Guidelines requirements
A	Unobstructed width	A ≥ 600 mm	A ≥ 700 mm
B	Top handrail height	B = 1000 mm	B = 1000 mm
C	Intermediate rail height	C = 500 mm	C ≤ 540 mm
D	Distance between stanchions	D ≤ 3m	D ≤ 1500 mm
E	Distance between stanchions across gap (top and middle rails connected)	E ≤ 550 mm	E ≤ 550mm
F	Vertical clearance	-	F ≥ 100mm
G	Lateral clearance	-	G ≥ 60 mm

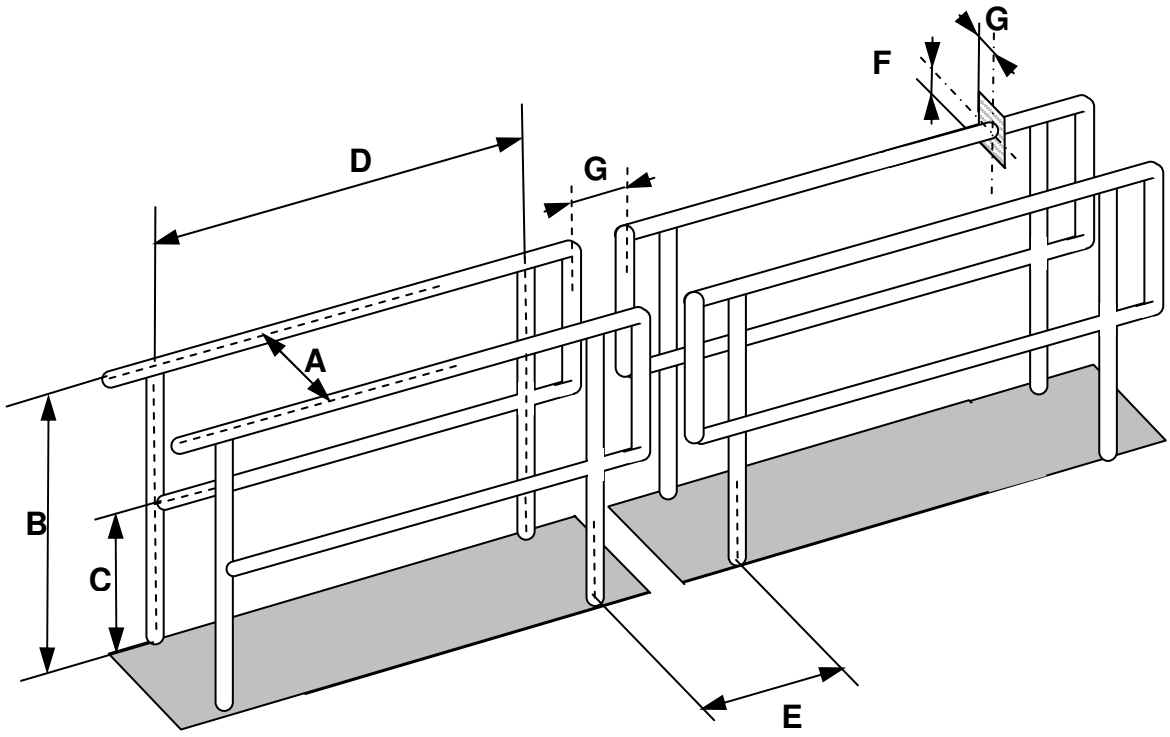


Figure 5: Requirements for walkways

2.1.1.6. Requirements for handrails – 2

	Dimension	IMO-IACS requirements	Guidelines requirements
A	Handrail diameter	-	30mm ≤ A ≤ 60mm 45 mm recommended
B	Gap between handrail sections	B ≤ 50mm	B ≤ 50 mm
C	Outside radius of the bent part	C ≤ 100 mm	C ≤100 mm
D	Distance between stanchions across gap (top and middle rails not connected)	D ≤ 350mm	D ≤ 350mm

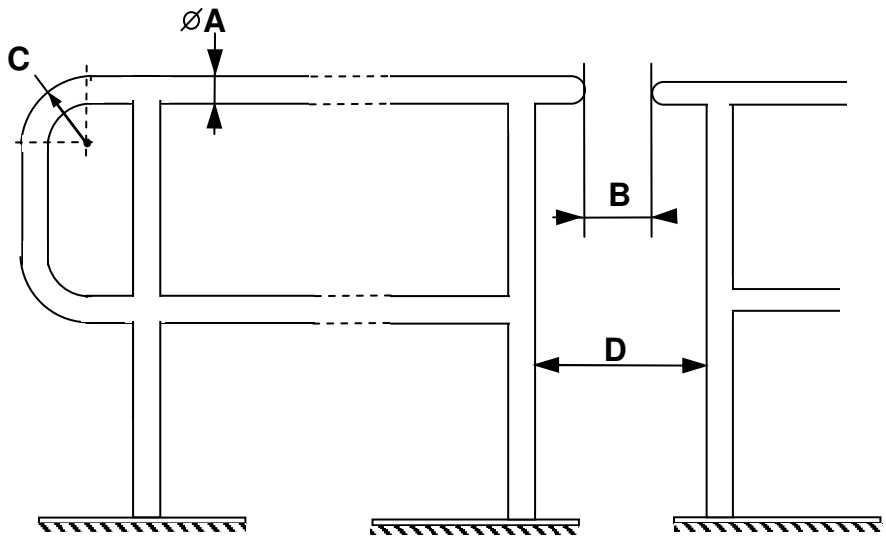


Figure 6: Requirements for handrails

2.1.2. Handles

2.1.2.1. Requirements for handles

	Dimension	IMO-IACS requirements	Guidelines requirements
A	Handle diameter	-	30 mm ≤…A ≤ 50 mm 35mm recommended
B	Handle outside radius of the bent part	-	B ≥ 25 mm 50 mm recommended
C	Handle depth	-	C ≥ 80 mm

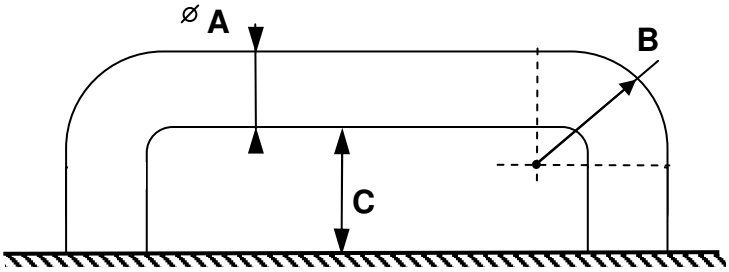


Figure 7: Requirements for handles

2.1.2.2. Requirements for handles – clearance

	Dimension	IMO-IACS requirements	Guidelines requirements
A	Vertical clearance	-	A ≥ 370 mm
B	Lateral clearance	-	B ≥ 95 mm

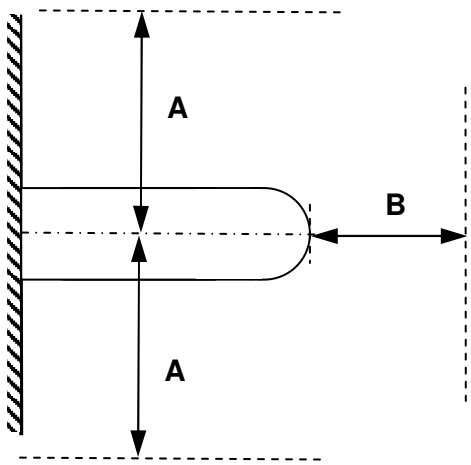


Figure 8: Requirements for handles (clearance)

2.2. Openings

This section deals with openings in general: manholes, hatches as well as light openings and ballast management openings. The vertical and horizontal openings used as means of access should be provided with relevant handles and steps to allow safe use (both sides of the opening should be fitted). The clearance around an opening should ensure ease of use and with no obstruction.

For horizontal openings, light openings and other openings that are not used as means of access, particular attention should be paid to prevent people from falling into them. This could be done, depending on the case, by designing relevant covers for hatches and manholes, locating the opening in an appropriate place and designing protective bars and guardrails around them.

The access openings should not be obstructed by pipes unless the clearance is sufficient for a safe use, as specified in the following tables and figures. For some locations onboard, such as ballast tanks, peaks, double hull spaces, the structures to be accessed should be provided with at least one exit with unobstructed openings.

Note: These guidelines do not address the design of light openings (openings used to light indoor compartments). However, it is necessary to consider the risk of falling into this type of opening. Their size, location and arrangement should be set in accordance with this risk.

In some cases such as shown in figure 9 below, basic guards can prevent people from falling in a light opening.

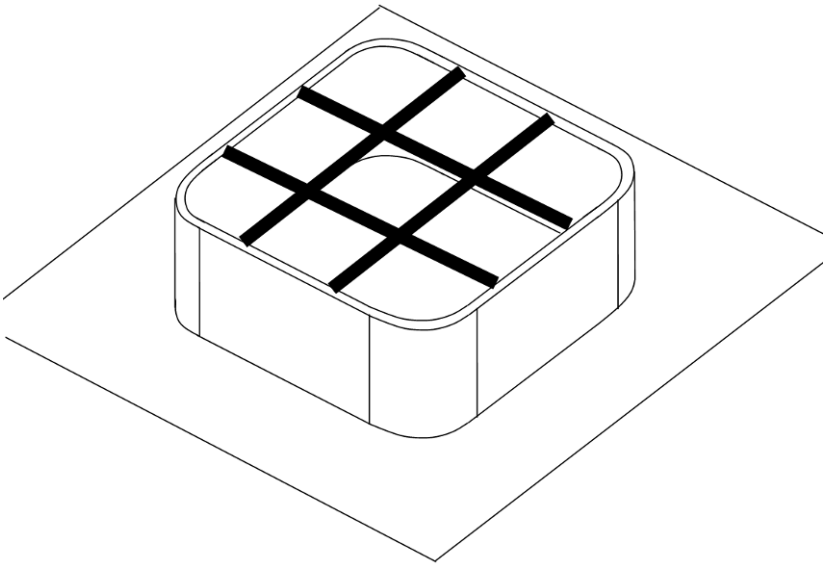


Figure 9: Open hatch guards

2.2.1. Vertical openings

2.2.1.1. Requirements for vertical openings – design 1

	Dimension	IMO-IACS requirements	Guidelines requirements
A	Sill height	A ≤ 600 mm	400 mm ≤ A ≤ 500 mm **(1)**
B	Vertical opening height	B ≥ 800 mm	B ≥ 950 mm
C	Vertical opening width	C ≥ 600 mm	C ≥ 750 mm
D	Corner radii	D = 300 mm	D ≥ 375 mm
I	Vertical handle lateral distance to opening	-	I = 50 mm
J	Vertical handle length	-	J ≥ 600 mm
K	Horizontal handle length	-	K ≥ 500 mm
L	Horizontal handle distance above opening	-	50 mm ≤ L ≤ 200 mm
(1) This dimension is based on ergonomics and does not pretend to replace the already existing safety requirements.			

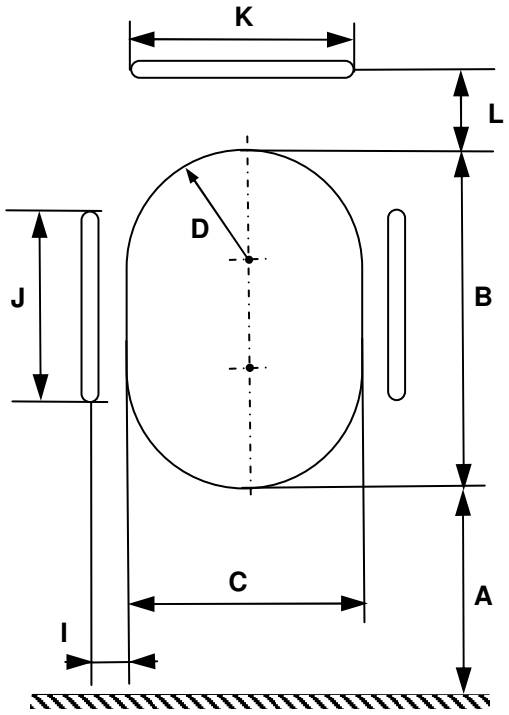


Figure 10: Requirements for vertical openings – Design 1

2.2.1.2. Requirements for vertical openings – design 2

	Dimension	IMO-IACS requirements	Guidelines requirements
A	Sill height	A ≤ 600 mm	400 mm ≤ A ≤ 500 mm **(1)**
E	Vertical opening height	E ≥ 850 mm	E ≥ 950 mm
F	Vertical opening width	F ≥ 620 mm	F ≥ 750 mm
G	Radius upper half	G = 310 mm	G ≥ 375 mm
H	Radius lower half	H = 200 mm	H ≥ 265 mm
I	Vertical handle lateral distance to opening	-	I = 50 mm
J	Vertical handle length	-	J ≥ 600 mm
K	Horizontal handle length	-	K ≥ 500 mm
L	Horizontal handle distance above opening	-	50 mm ≤ L ≤ 200 mm
(1) This dimension is based on ergonomics and does not pretend to replace the already existing safety requirements.			

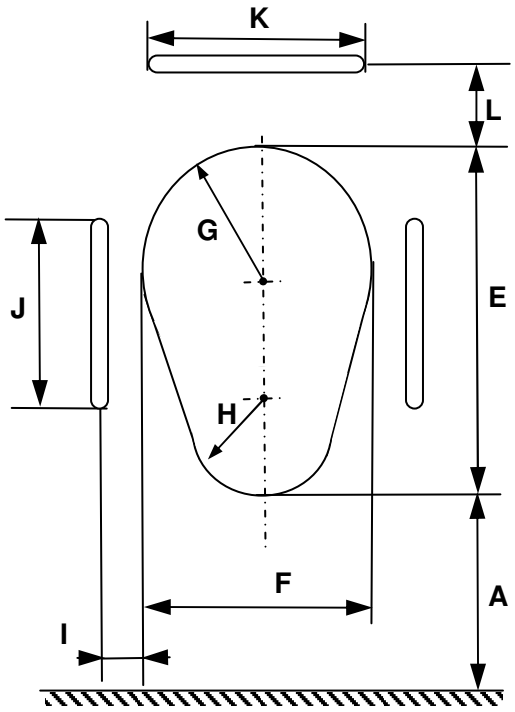


Figure 11: Requirements for vertical openings – Design 2

2.2.1.3. Requirements for vertical openings – design 3

	Dimension	IMO-IACS requirements	Guidelines requirements
I	Vertical handle lateral distance to opening	-	I = 50 mm
J	Vertical handle length	-	J ≥ 600 mm
K	Horizontal handle length	-	K ≥ 500 mm
L	Horizontal handle distance above opening	-	50 mm ≤ L ≤ 200 mm
M	Vertical manhole diameter	M ≥ 600 mm	M ≥ 750 mm
N	Sill height	N ≤ 600 mm	N ≤ 500 mm

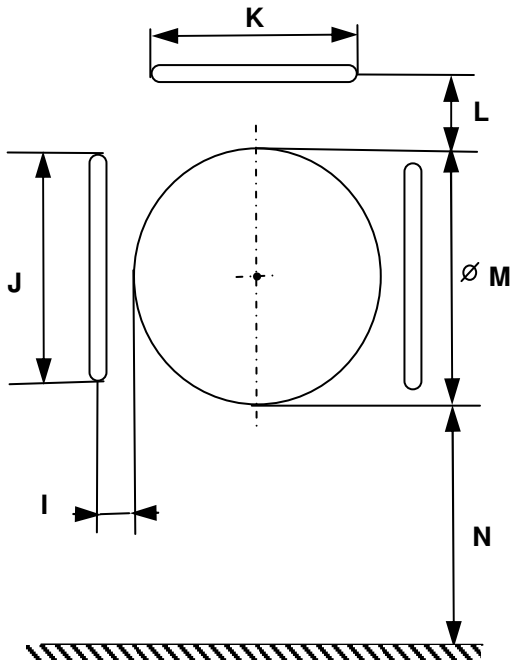


Figure 12: Requirements for vertical openings – Design 3

2.2.1.4. Requirements for access to vertical openings

	Dimension	IMO-IACS requirements	Guidelines requirements
A	Steps width	-	A ≥ 350 mm
B	Steps depth	B ≥ 150 mm	B ≥ 150 mm
C	Steps section	22×22 mm	22×22 mm ≤ CxC ≤ 35×35 mm 25×25 mm is recommended
D	Steps edge height	-	D = 60 mm
E	Vertical distance between steps	-	250 mm ≤ E ≤ 350mm
F	Vertical distance between opening and closest step	-	400 mm ≤ F ≤ 500 mm

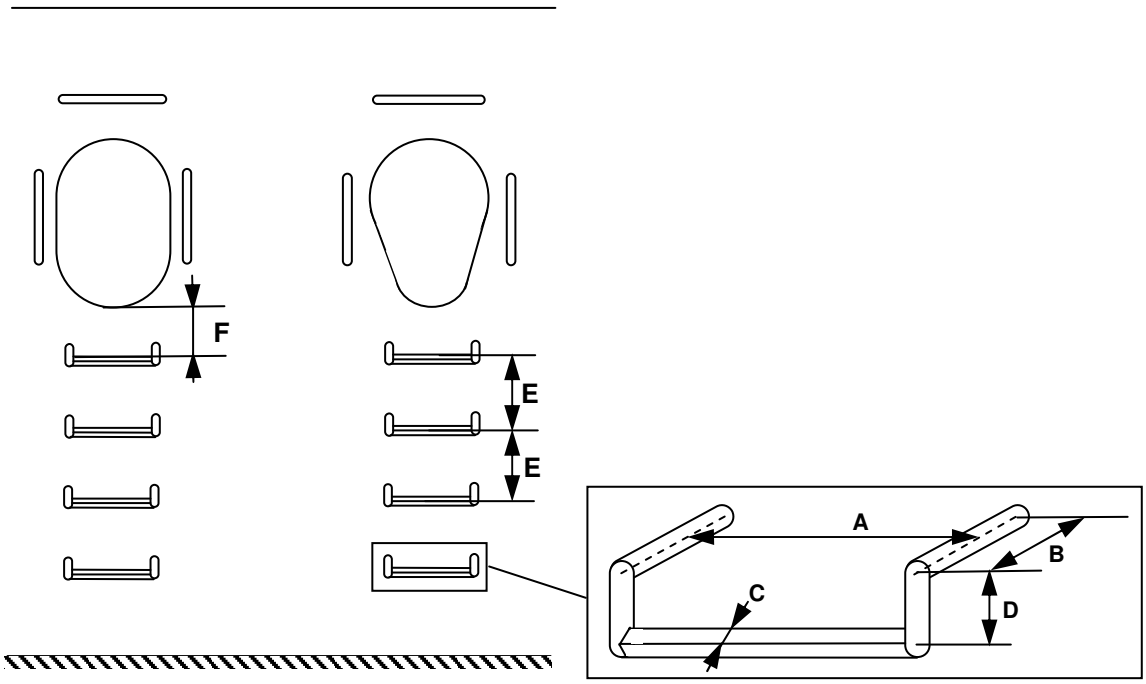


Figure 13: Requirements for access to vertical openings

2.2.2. Horizontal openings

2.2.2.1. Requirements for horizontal openings – other than access openings

	Dimension	IMO-IACS requirements	Guidelines requirements
A	Clearance	-	A ≥ 1m
B	Distance between vertical opening and horizontal opening	-	B ≥ 2m
C	Distance between two horizontal openings	-	C ≥ 1m
D	Distance between protection bars for horizontal openings	-	D ≤ 200 mm

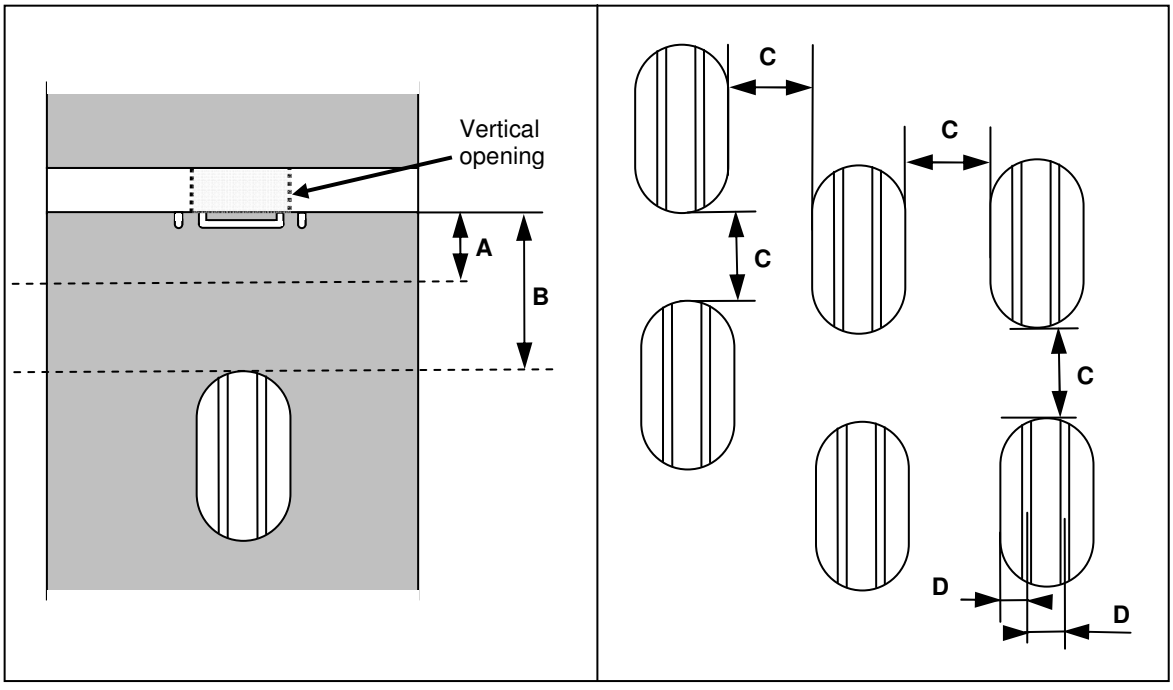


Figure 14: Requirements for horizontal openings (other than access openings)

2.2.2.2. Requirements for horizontal openings

	Dimension	IMO-IACS requirements	Guidelines requirements
A	Horizontal opening length	A ≥ 800 mm	A ≥ 900 mm
B	Horizontal opening width	B ≥ 600 mm	B ≥ 800 mm
C	Horizontal opening corner radii	C = 300 mm	C ≥ 400 mm
D	Vertical distance between walking surface and ladder's first rung	-	250 mm ≤ D ≤ 350mm
E	Gap between rails	-	E = 450 mm

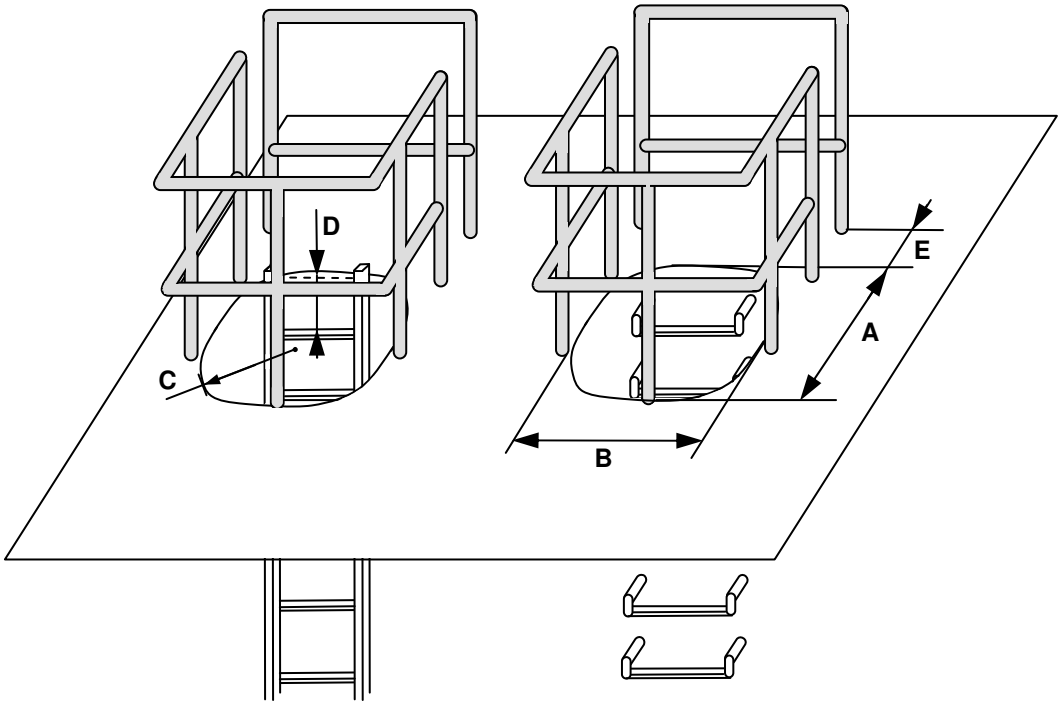


Figure 15: Requirements for horizontal access openings

Note: Onboard container ships, when using the elevated passageways to circulate through the containers, it is not often easy to detect the horizontal openings, which are not systematically provided with covers. The risk of falling is high. Consequently, covers should be installed in such situations and the openings made clearly visible. In addition, the similar situation can occur for the platforms in the hold spaces of LPG tankers.

2.3. Vertical ladders

This section, dedicated to vertical ladders, focuses on the arrangements around them such as the relevant handles, steps, guardrails, handrails, cages and platforms.
The aim of these requirements is to ensure that the person climbing on the ladders:

- can easily climb on and off the ladder (appropriate arrangements);
- has sufficient space around him in order not to bump into obstacles;
- has sufficient space to use the ladder as a platform for surveying;
- cannot fall from a height that would cause him serious injuries;
- cannot slip from the ladder;
- feels protected (safe) when using the ladder.

2.3.1. Requirements for embedded steps

In some places, such as chain lockers where vertical ladders cannot be used (the chains would damage the ladder), built-in steps (or embedded steps) are recommended. The design presented in Figure 16 allows people to use the steps for both feet and hands.

	Dimension	IMO-IACS requirements	Guidelines requirements
A	Vertical distance between in line steps	-	250 mm ≤ A ≤ 350mm 300mm is recommended
B	Vertical distance between staggered steps	-	125 mm ≤ B ≤ 175mm 150 mm is recommended
C	Horizontal distance between steps	-	C = 350 mm
D	Step height	-	D = 125 mm
E	Step depth	-	E = 150 mm
F	Step width	-	F = 170 mm
G	Edge dimensions	-	G = 20 mm

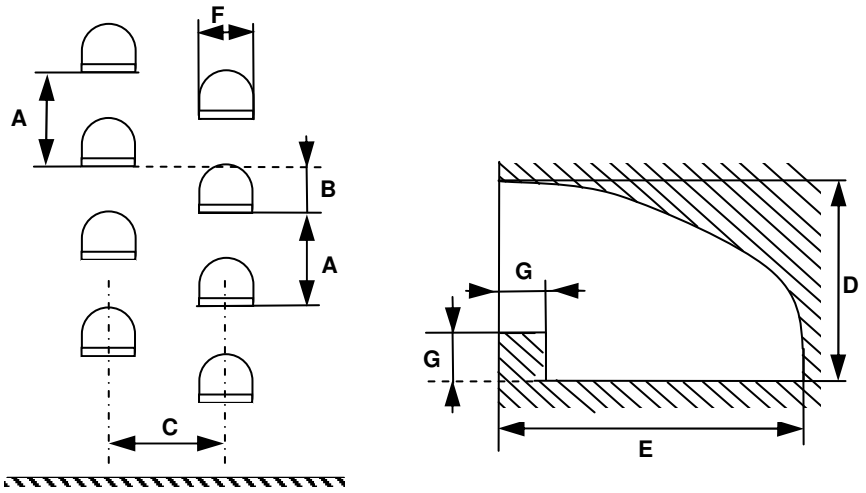


Figure 16: Requirements for embedded steps

2.3.2. Requirements for ladders with curved stringers

	Dimension	IMO-IACS requirements	Guidelines requirements
A	Stringer radius	-	A = 250 mm
B	Height above landing	-	B ≥ 1000 mm
C	Ladder width (distance between stringers)	-	C ≥ 500 mm 550 mm is recommended

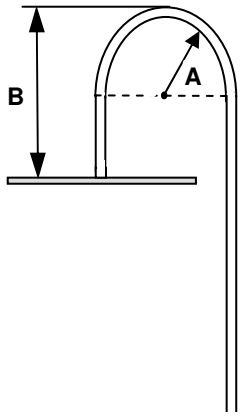


Figure 17: Requirements for ladders with curved stringers

2.3.3. General requirements for vertical ladders

	Dimension	IMO-IACS requirements	Guidelines requirements
A	Ladder height	A ≤ 6 m	A ≤ 6 m
B	Distance from landing platform to overhead obstructions	-	B ≥ 2020mm
C	Distance between centre of rungs and wall	C ≥ 150 mm	C ≥ 150 mm
D	Lateral clearance	-	D ≥ 200 mm
E	Back clearance	-	E ≥ 900 mm

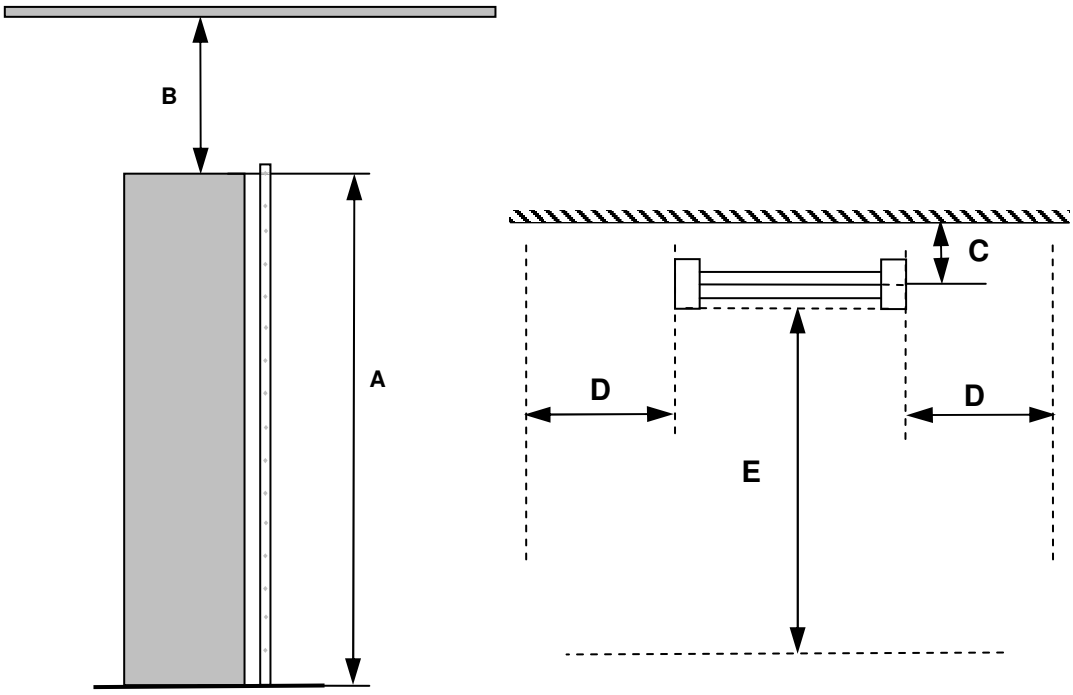


Figure 18: Requirements for vertical ladders (general)

2.3.4. Requirements for the arrangement of vertical ladders – 1

Contrary to the recommendations from MSC 158(78) Table 1 requirement 2.3, ladders should not be located in line but in an alternate way in order to limit the height of potential falls from ladders, and consequently to reduce their severity (see Figure 19).

	Dimension	IMO-IACS requirements	Guidelines requirements
A	Ladder width	A ≥ 350 mm in general A ≥ 300 mm for access to hold frames	A ≥ 400 mm 450 mm is recommended
B	Vertical distance between rungs	250 mm ≤ B ≤ 350mm	250 mm ≤ B ≤ 350mm
C	Lateral distance between two adjacent sections of ladder (linking platform)	At least the width of the ladder	C ≥ 500 mm
D	Gap length between wall and guardrail	-	D ≥ 850 mm
E	Handles height above walking surface	-	E = 1000 mm
F	Lateral distance between ladder and linking platform	-	200 mm ≤ F ≤ 350 mm
G	Rung dimensions (square bars)	G ≥ 22×22 mm	22×22 mm ≤ G ≤35×35 mm 25×25 mm is recommended

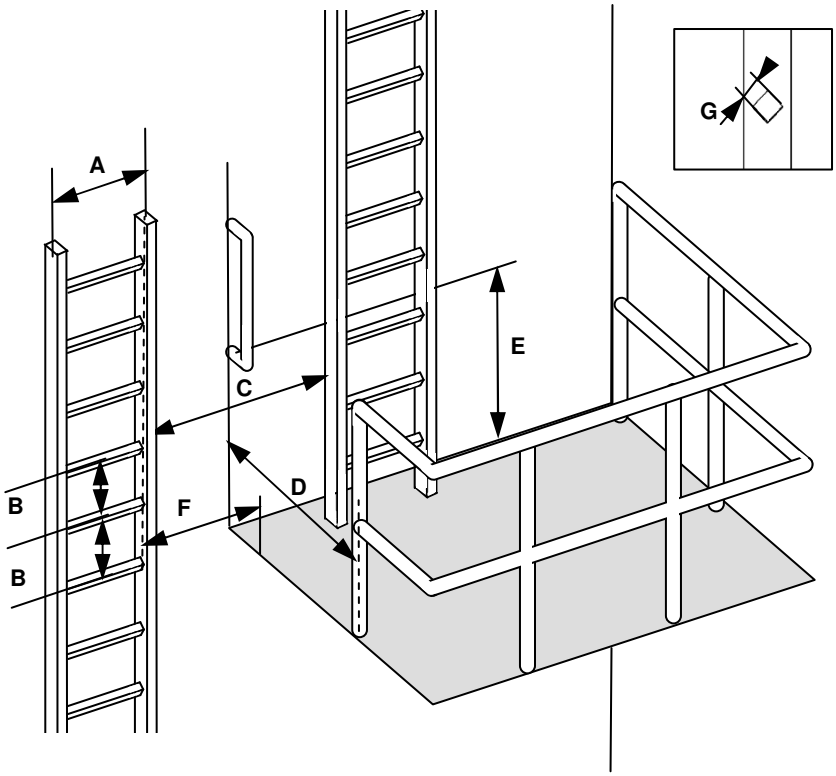


Figure 19: Requirements for vertical ladders (arrangements)

If the platform is used for inspection and maintenance, it needs to provide sufficient room to work on. The operator should be able to kneel on the platform as well as leave and squat his tools on it. These platforms should follow the requirements below.

	Dimension	IMO-IACS requirements	Guidelines requirements
A	Platform width	-	A ≥ 900 mm
B	Platform length	-	B ≥ 980 mm

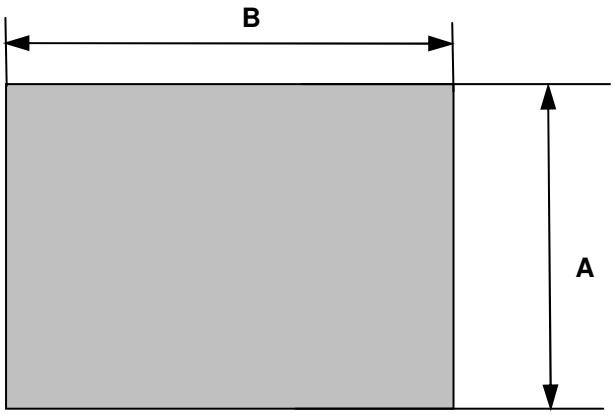


Figure 20: Requirements for work platforms

2.3.5. Requirements for the arrangement of vertical ladders – 2

	Dimension	IMO-IACS requirements	Guidelines requirements
A	Horizontal opening width	A ≥ 600 mm	A ≥ 800 mm
B	Horizontal opening length	B ≥ 800 mm	B ≥ 900 mm
C	Steps depth	C ≥ 150 mm	C = 150 mm
D	Steps width	-	Same width as the ladder
E	Vertical distance between steps	-	E ≥ 250 mm 350 mm is recommended
F	Handles height above walking surface	-	F = 1000 mm
G	Ladder height above landing	G ≥ 1000 mm	G ≥ 1450 mm
H	Distance from the back edge of the opening and the centre of the rungs	-	H ≥ 750 mm
I	Handles length	-	I ≥ 600 mm
J	Clearance	-	J ≥ 880 mm

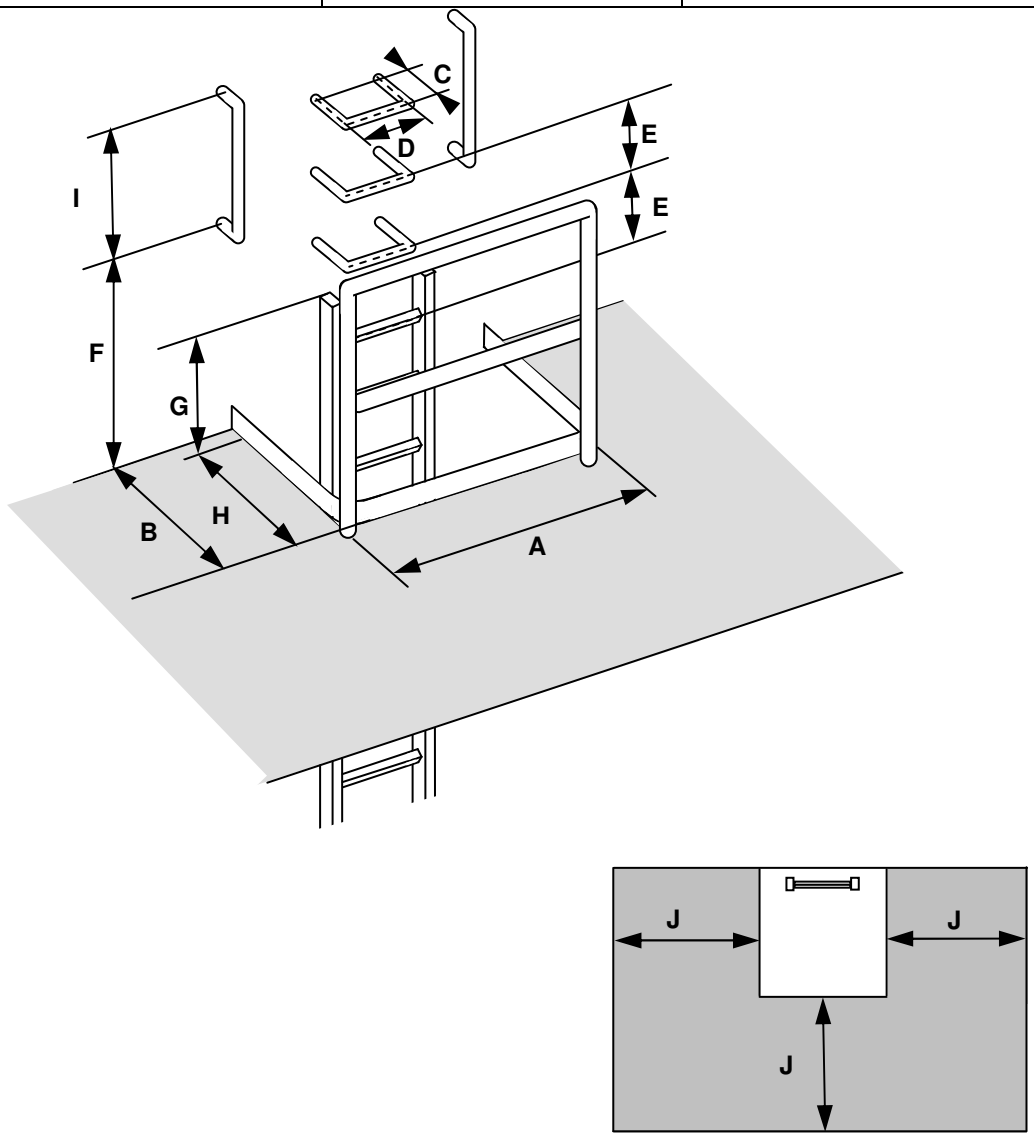


Figure 21: Requirements for vertical ladders (arrangements)

2.3.6. Requirements for safety cages

Cages can be very useful for improving safety of vertical ladders. They should be used each time it is possible.

	Dimension	IMO-IACS requirements	Guidelines requirements
A	Distance to bottom	-	A ≥ 2020 mm
B	Distance between horizontal rails	-	B ≤ 1250 mm
C	Radius	-	C = 480 mm
D	Lateral clearance	-	D = 250 mm
E	Back clearance	-	E = 800 mm
F	Spacing of vertical rails	-	F = 35°

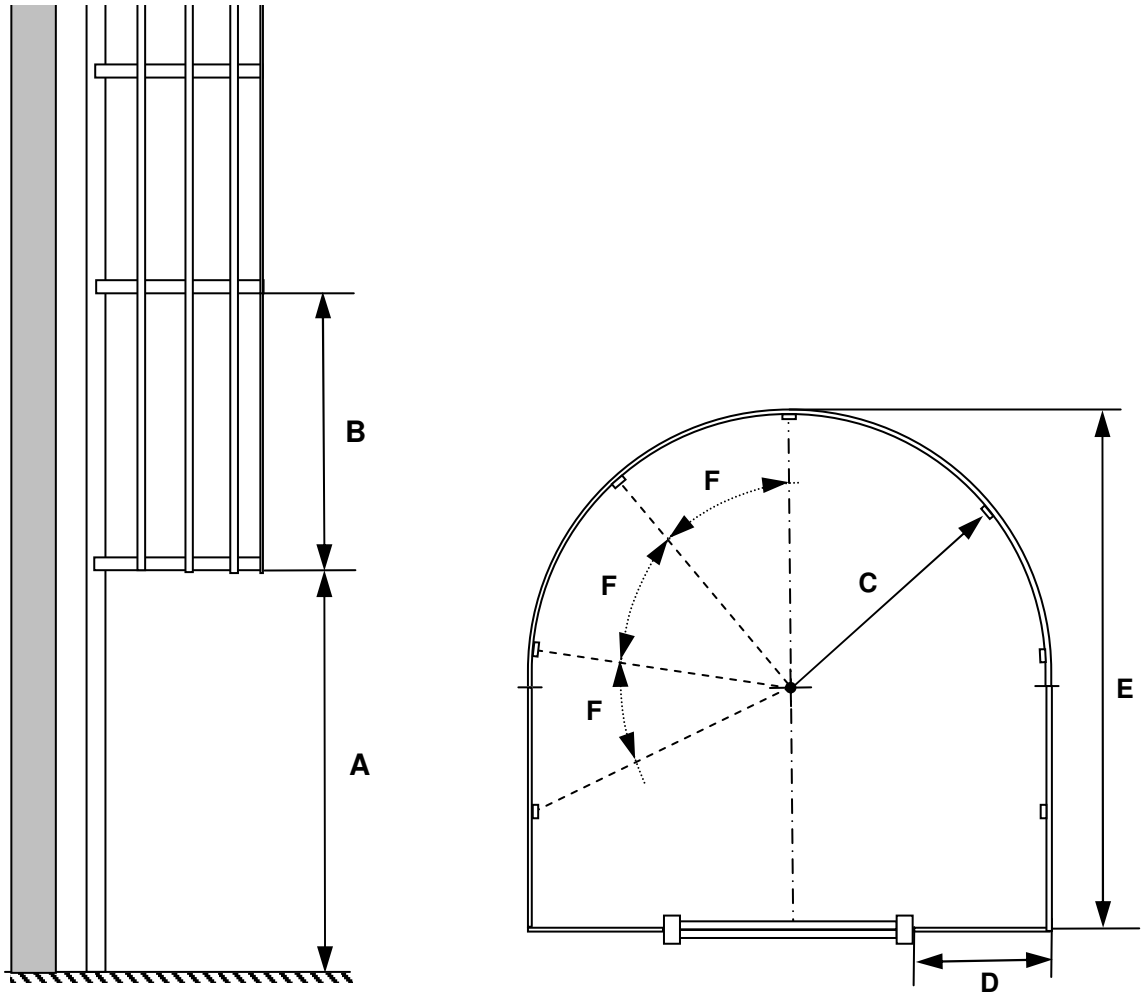


Figure 22: Requirements for safety cages

2.4. Inclined ladders or stair ladders

Inclined ladders are the means of access that record the highest number of accidents since their inclination angle can reach 70°. It is easy to loose one's balance especially when going downstairs. The worst case is when the user is carrying an object that requires that one or both hands cannot help him recover from a trip by grasping the handrails.

Note: Guardrails and handrails are fundamental for the design of stair ladders.

2.4.1. General requirements for inclined ladders

	Dimension	IMO-IACS requirements	Guidelines requirements
A	Height (rise)	A ≤ 6 m	A ≤ 6 m
B	Distance from landing platform to overhead obstructions	-	B ≥ 2020mm
C	Guardrail height	-	1100 mm ≤ C ≤ 1200 mm

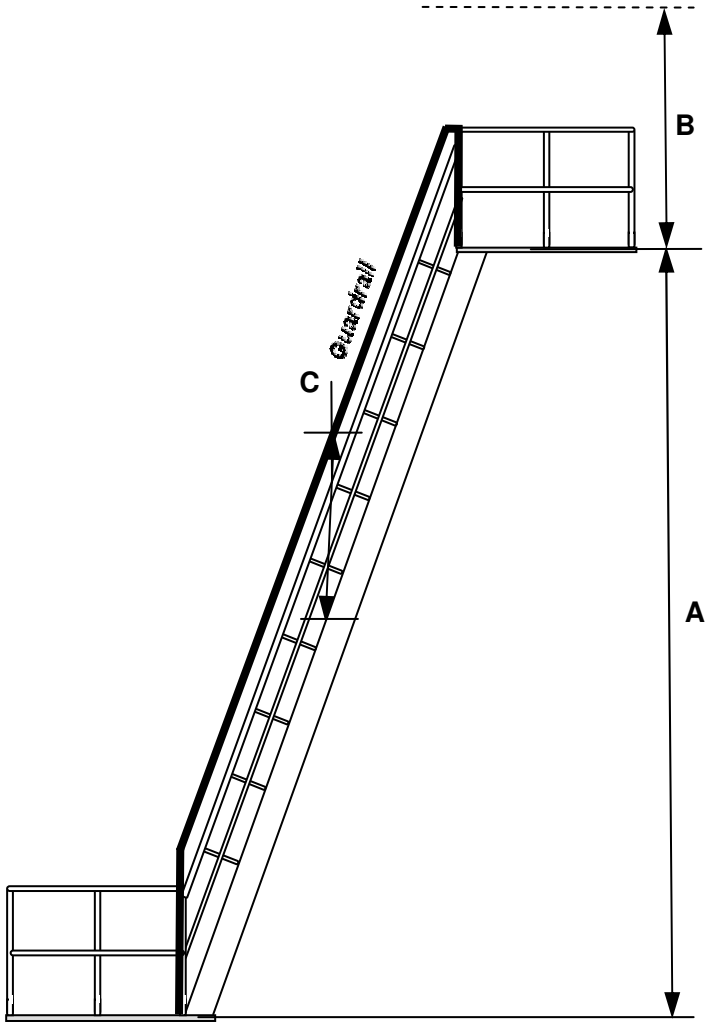


Figure 23: Requirements for the inclined ladders (general)

2.4.2. Detailed requirements for inclined ladders

	Dimension	IMO-IACS requirements	Guidelines requirements
A	Inclination	A < 70°	50° ≤ A < 70° 50° ≤A ≤ 60° is recommended
B	Vertical distance between treads	200 mm ≤ B ≤ 300 mm	200 mm ≤ B ≤ 300 mm 200 mm for a pitch line of 50° 250 mm for a pitch line of 60 ° 300 mm for a pitch line of 70°
C	Top handrail height	-	840 mm ≤ C ≤ 1000 mm above the pitch line
D	Intermediate rail height	-	Half the height of the top handrail is recommended
E	Horizontal distance between bars	-	90 mm ≤ E ≤ 140 mm 140 mm for a pitch line of 50° 125 mm for a pitch line of 60° 90 mm for a pitch line of 70°
F	Bar dimensions (if treads are made of two square bars)	F ≥ 22×22mm	22×22mm ≤ F ≤ 35×35 mm 25×25 is recommended
G	Clear width	G ≥ 450 mm for cargo holds G ≥ 400 mm else	G ≥ 560 mm
H	Distance between the inclined ladder face and obstructions	H ≥ 750 mm	H ≥ 1300 mm
I	Treads width (if treads are not made of two square bars)	-	120 mm ≤ I ≤ 180 mm 170 mm for a pitch line of 50° 155 mm for a pitch line of 60° 120 mm for a pitch line of 70°

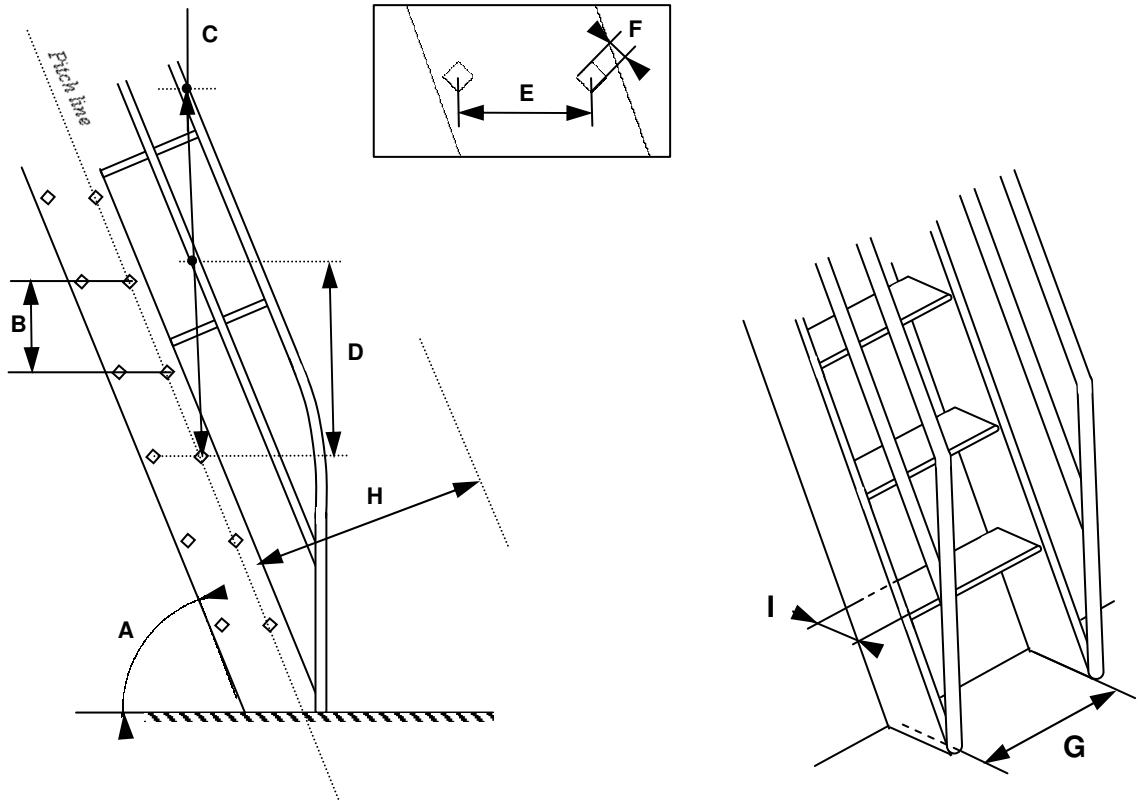


Figure 24: Requirements for the inclined ladders (detailed)

2.4.3. Requirements for the arrangement of inclined ladders

In order to reduce the risk of tripping because of the sills when using the stairs and stair ladders, the step should be on the same level as the sill edge.

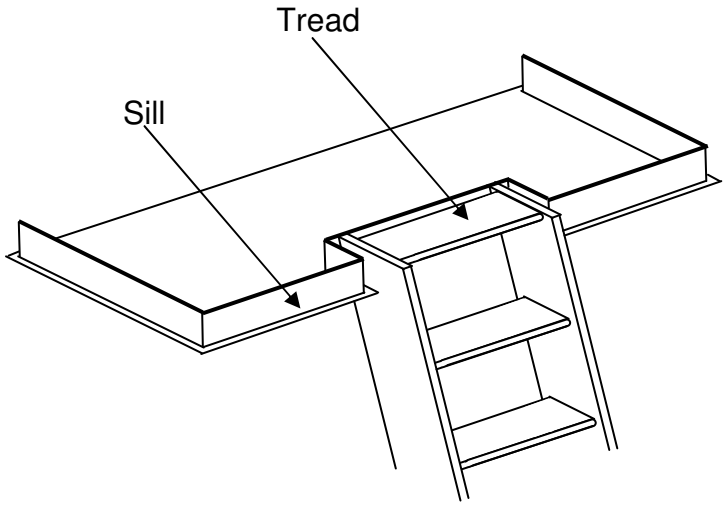


Figure 25: Requirements for the inclined ladders (arrangement)

2.5. General requirements, advice and best practice

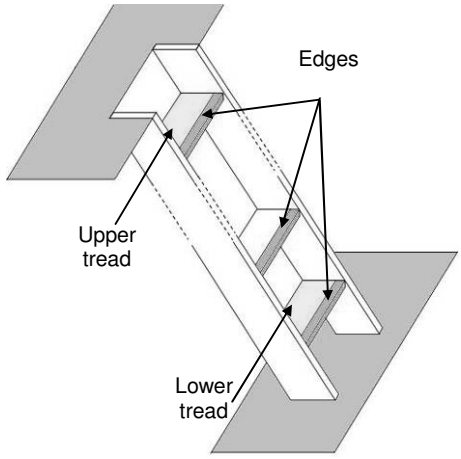
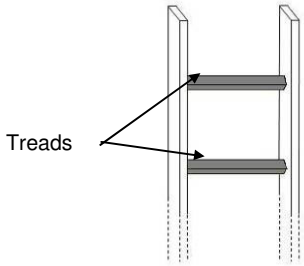
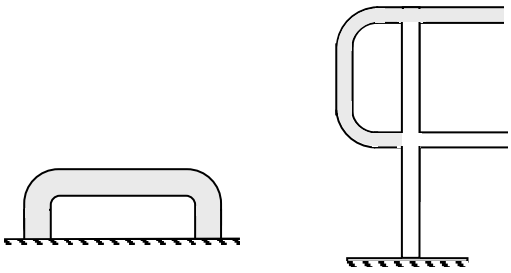
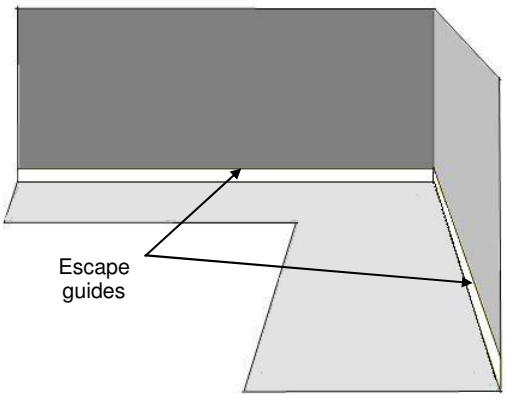
2.5.1. Marking of the means of access

This section describes one of the most important points in the design of the means of access. In fact, one of the core principles to adopt when designing the human-machine interface of a system is to provide easy identification of the commands; they have to be of the right colour and within the 'operator's' line of sight. These principles have to be applied to the design of means of access when considering the numerous accidents occurring because the danger could not be easily identified visually.

The first element to take into account is the lighting of the location where the means of access is fitted. Open decks can be poorly enlightened at night and visibility can be very degraded by the weather conditions. Indoor spaces can be poorly enlightened as well, because of the lack/unsuitability of light holes or because of insufficient artificial lighting. Finally, some spaces that are sometimes or rarely used such as ballast tanks are in total darkness and enlightened with flashlights.

The second element is that the means of access, and the dangers associated with their use have to be marked so that they can be, respectively, quickly identified and easily prevented.

Consequently, it is recommended that particular attention be paid to these two elements. Below are some of the best practices that can be encountered on some ships.

<table>
<tr><th colspan="2">Description</th><th>Marking</th><th>Explicative drawings</th></tr>
<tr><td rowspan="2">Stair ladder treads and steps</td><td>In areas that are rarely enlightened</td><td>Highly visible colour or reflective strips on the edges
Highlight the top and bottom steps a different colour from other steps and decks</td><td rowspan="2"> 
</td></tr>
<tr><td>In areas that are exposed to light a certain part of the day</td><td>Dayglow paint on the edges
highlight the top and bottom steps a different colour from other steps and decks</td></tr>
<tr><td colspan="2">Treads of vertical ladders</td><td>Highly visible colour, dayglow paint or reflective stripes</td><td> 
</td></tr>
<tr><td colspan="2">Handles</td><td>A unique and quite visible colour for everything that can be grasped, e.g. handles (yellow for instance).</td><td>  </td></tr>
<tr><td colspan="2">Escape ways</td><td>High visibility escape guides that can be seen through a dense smoke.</td><td> 
</td></tr>
</table>

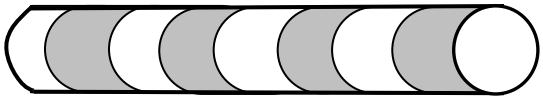
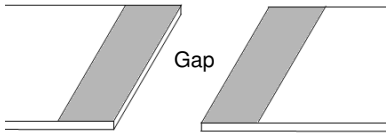
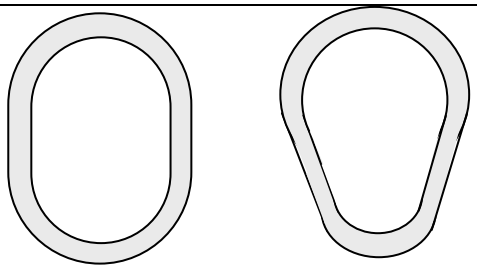
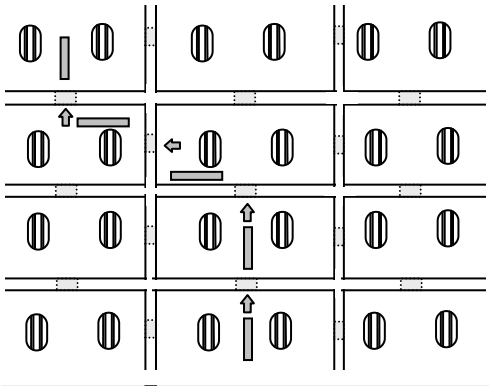
Obstacles such as pipes	Stripped which colour dependent on the lighting of the area. (for instance black and yellow, black and reflective or white and dayglow paint)	
Edges of obstacles such as gaps	Strips of colour dependent on the lighting of the area	
Outline of openings (especially horizontal ones)	Strips of colour dependent on the lighting of the area	
Ballast tanks, peaks and other very dark and complex areas	Arrows and stripes to show the way. Reflective paint or materials can be used or highly visible colours (yellow for example).	

Figure 26: Best practices and advice for the marking of the MAs

2.5.2. Slip resistance

Due to many factors such as weather conditions, ship motions, or oil and water leaks, the walking surfaces can be covered with slippery substances. Moreover, some places such as ballast tanks and peaks have slippery muddy walking surfaces while the visibility is very bad.

For these reasons, a strong focus has to be put on the different surfaces that are likely to cause slips, trips and falls. Different solutions can then be adopted.

The slip resistance of walking surfaces and tread finishes characterised by the coefficient of friction has to be considered. One of the best solutions is to obtain a good coefficient of friction i.e. a value > 0.75 (widely considered as implying a very good slip resistance) both for dry, unpolished and wet surfaces. This can be done by using high grip mats, paints or tapes (e.g. carborundum finish or textured).

Note: Special attention should be paid not to use solutions that increase the risk of tripping. Anti-slip strips for instance should not have a thickness above 6mm.

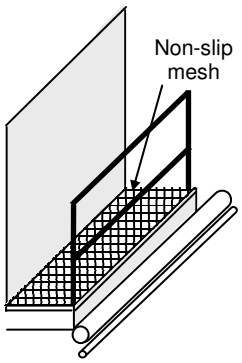
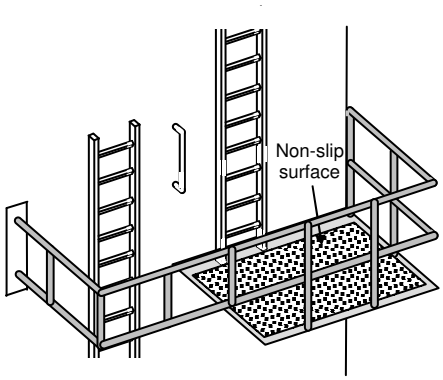
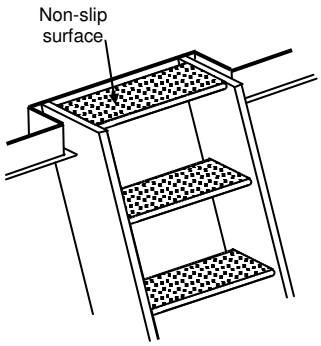
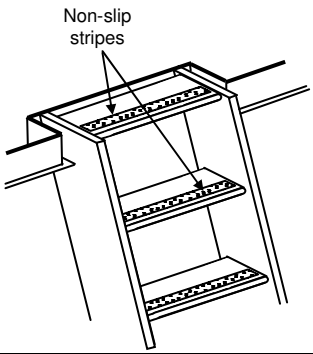
Description	Marking	Explicative drawings
Walking surface of elevated passageways and other areas exposed to water and slippery substances	Non slip matting or fibreglass mesh	
Walking surface of platforms	Non slip surface	
Stair ladders treads and steps	The treads should be made of non-slip surface. Personnel should be able to climb with confidence even if they have oil or water on their shoes. Non-slip surfaces or non-slip strips on the step edge can be used.	 

Figure 27: Best practices and advice for slip resistance of the MAs

2.5.3. Training

Seafarers, shipyard workers, surveyors and any other person who has to use the means of access should have specific instruction relating to the risks they are exposed to when using the means of access. They should also be taught the best practices for the use of each type of means of access with a description of the specific equipment (e.g. gloves and harnesses) they should use.

Note: The physical condition of persons using means of access should be considered, in particular for the most dangerous ones.

2.5.4. Maintenance

It is crucial that the means of access are designed to last. This means that the materials used and the paint applied should ensure that the means of access are sufficient for the environment in which they are fitted. Corrosion should be particularly addressed. It is very important that the means of access maintained in a good condition. The poor condition of a ladder, for instance, can cause a severe fall.

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