Guide for

Ergonomic Notations

September 2021

GUIDE FOR

ERGONOMIC NOTATIONS
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Foreword *(1 September 2021)*

Ergonomics is defined as "the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and methods to design in order to optimize human well-being and overall system performance" (International Ergonomics Association, 2011).

This Guide provides requirements for ABS ergonomic notations in the following areas:

- Ergonomic Topsides Design (**ERGO TOP**) notation is directed at assessing the human and topsides structure fit and compatibility, including external ramps, ladders, platforms, and other topsides structures (weather deck area) associated with crew mobility and task performance.
- Ergonomic Enclosed Space Design (**ERGO ES**) notation is directed at assessing the human and compatibility of areas inside the skin of the vessel below the main deck (whether of a ship or offshore structure). These include interior ramps, passageways, ramps hatches and scuttles, and other below-decks structures associated with crew mobility and task performance.
- Ergonomic Valves Design (**ERGO VALVE**) notation is directed at assessing the access, orientation, and use of operating and maintenance valves with regard to accessibility and ease of identification and use.
- Ergonomic Maintenance Design (**ERGO MAINT**) notation is directed at assessing the access and use of maintenance locations (spaces, platforms, access aids) with regard to maintenance safety and ease of accessibility.

The September 2021 edition replaces the requirements for surveys after construction with references to Section 7-9-16 of the ABS *Rules for Survey After Construction (Part 7)*.

This Guide becomes effective on the first day of the month of publication.

Users are advised to check periodically on the ABS website www.eagle.org to verify that this version of this Guide is the most current.

We welcome your feedback. Comments or suggestions can be sent electronically by email to rsd@eagle.org .

GUIDE FOR

ERGONOMIC NOTATIONS

CONTENTS

SECTION 1
Introduction

1 Scope and Application

This Guide has been created to offer ergonomic (**ERGO**) notations for selected working areas on vessels classed with ABS, including topsides design, enclosed space design (e.g., on or below the main deck on the interior of the vessel), design for valve access and use, and design for operability and maintainability.

This Guide has been developed with the objective of promoting an ergonomically-focused design and construction of ABS-classed vessels. This Guide offers the following ergonomic notations (separately requested, up to four different notations are offered):

- Ergonomic Topsides (**ERGO TOP**), which establishes a level of ergonomic design promoting human performance and safety when working with topside structures
- Ergonomic Enclosed Space (**ERGO ES**), which establishes ergonomic design when working within enclosed spaces (whether of a ship or an offshore structure)
- Ergonomic Valve (**ERGO VALVE**), which establishes ergonomic design when accessing and operating valves
- Ergonomic Maintenance (**ERGO MAINT**), which establishes ergonomic design for accessing maintenance items.

Note that **ERGO VALVE** and **ERGO MAINT** each require the conduct of an identification of relative priority regarding level of accessibility depending of frequency of access and importance to safety and operations. Different requirements exist depending on these factors. Failure to perform early-on determinations of priorities may therefore influence the granting of notations.

The criteria presented in this Guide are based on accepted ergonomic and safety engineering principles. However, some criteria may differ from national, flag, or other design requirements. In instances where national, flag or other requirements are more limiting than those presented in this Guide, those requirements take precedence.

2 Using this Guide

This Guide presents requirements for several optional notations. Many of the requirements overlap other notations, and in the interest of brevity, Section 3, “Requirements” lists individual groupings of requirements that are based on the notation being sought. The requirements expressed in Section 4, “Requirements for Notations” are displayed in 1/2 TABLE 1, “Requirements by Topic”.

TABLE 1
Requirements by Topic

Section 4 Requirements	*Requirements Topic*
4/1	Stairs
4/2	Walkways and Ramps
4/3	Vertical and Inclined Ladders
4/4	Guard Rails and Climber Safety Devices
4/5	Fall Protection from Secondary Fall Points
4/6	Work Platforms
4/7	Handles
4/8	Hatches
4/9	Doors and Scuttles
4/10	Manual Valve Operation, Access, Location, and Orientation
4/11	Maintenance Access

3 Terminology

Access Aid: A device that makes operation of, or access to, operating or maintenance components possible, or more immediate. For example, a ladder to an access platform.

Accessibility: The ability for personnel to access equipment that requires maintenance, inspection, removal, or replacement while wearing the appropriate clothing, including personal protective equipment, and the ability to use all necessary tools and test equipment.

Active Protection: A safety design or device that actively (or directly) requires a person to take specific actions before a potential loss, for example, donning a fall arrestor fitted to both the ladder and the climber.

Anthropometrics: The measurement of human variability of body dimensions and strength as a function of gender, race, and regional origin.

Case: The part of equipment that encloses and protects the equipment from its surroundings and protects the surroundings - including personnel - from the equipment.

Crew Member: Any person on board a vessel, including the Master, who is not a passenger. This term is used interchangeably throughout this document with “seafarer”.

Design Load: The maximum intended load, being the total of all loads including the weight of the personnel, materials, and equipment, including the means of access structure.

Enclosed Space: For the purpose of the **ERGO ES** notation, an enclosed space is defined as the interior portions of a vessel where people work and live.

Guardrail or safety rail: Device for protection against accidental fall or accidental access to a hazardous area, with which stairs, step ladders or landings, platforms and walkways, or deck edges/fall points may be equipped.

Handrail: Top element designed to be grasped by the hand for body support which can be used individually or as the upper part of a rail.

Maintainability: The ability to carry out maintenance tasks, such as testing, servicing, calibrating, adjusting, removing, replacing or repairing rapidly and effectively in order to allow equipment and systems to achieve a specified level of performance.

Maintenance: All activities necessary to keep equipment in, or restore it to, a specified level of performance.

Maintenance Item, Critical: Includes those maintenance actions which are system and safety critical, meaning a system critical to the safe operation of the vessel cannot function without that aspect being functional, and moderate to frequent maintenance actions are required. These are referred to as Category 1 maintenance items for maintenance access criticality categorization purposes.

Maintenance Item, Non-Critical: Includes those maintenance actions which are not system critical as defined above but are maintenance actions that are required frequently for the proper operation of the vessel. These are referred to as Category 2 maintenance items for maintenance access criticality categorization purposes.

Maintenance Item, Infrequently Used Non-Critical: Includes those maintenance actions which are considered to be non-critical to system status and safety, and that do not require frequent access. These are referred to as Category 3 maintenance items for maintenance access criticality categorization purposes.

Manual Valve: A valve that is manually opened by a human operator using a handwheel, lever, chain, extender, or other hand-operated device.

Newton: SI unit of force. One Newton is equal to the amount of net force required to accelerate a mass of one kilogram at a rate of one meter per second squared.

Newton-Meters (N-m): SI unit of torque. One Newton-meter is equal to the torque resulting from a force of one Newton applied perpendicularly to a moment arm which is one meter long.

Operating Torque: The force an operator or maintainer exerts by pushing or pulling on a lever or turning a handwheel.

Passive Protection: A safety design or device that requires a person to take no specific action prior to a potential loss, for example, a safety cage permanently fitted to a ladder. See also "Active protection" above.

Pound Force: One pound force is equal to the gravitational force exerted on a mass of one pound on the surface of the Earth.

Reach Rod: A rod for operating a remote valve that would otherwise not be accessible (for example, to operate a valve below a deck grating).

Readily or Immediately Accessible Valves: Valves that are:

- Located in a space that can be entered without requiring tools or keys
- Clear of obstructions, moving equipment and hot surfaces
- Within operator's reach without requiring use of extenders, ladders, or other access aids.

Seafarer: Any person onboard a vessel, including the Master, who is not a passenger. This term is used interchangeably throughout this document with "crew member".

Shall: Expresses a provision that is mandatory.

Stair: One of a flight or series of steps for going from one level to another, as opposed to a ladder offering two vertical, or nearly vertical, risers between rungs forming a means of climbing up or down.

Toeboard: Solid lower part of a guard-rail on a landing to prevent the fall of objects from a floor level.

Topside: For the purposes of **ERGO TOP** notation, topsides are considered to be the weather deck and above, and that are exposed to the elements.

Valve, Critical: Valves that require rapid and/or frequent access during normal operations or emergency conditions. These are referred to as Category 1 Valves for valve criticality categorization purposes.

Valve, Non-Critical: Valves that are not critical for operations but that are required for routine maintenance. These are referred to as Category 2 Valves for valve criticality categorization purposes.

Valve, Infrequently Used Non-Critical: Valves that are not critical for operations or routine maintenance and that are infrequently used for particular tasks like commissioning, start-up, shutdown, or rarely performed maintenance tasks. These are referred to as Category 3 Valves for valve criticality categorization purposes.

Workspaces: Areas allocated for work. Categories of workspaces include: navigation spaces, service spaces (galley, laundry), and machinery spaces.

4 Notations

This Guide provides requirements for ABS notations in four separate areas, as follows:

- **ERGO TOP** notation is directed at assessing the human and topsides structures fit and compatibility, including external ramps, ladders, platforms, and other topsides structures (weather deck area) associated with crew safety and job performance.
- **ERGO ES** notation is directed at assessing the human fit and compatibility of areas inside the skin of the vessel on or below the main deck (whether of a ship or an offshore structure) . These include interior ramps, passageways, ramps hatches and scuttles, and other structures associated with crew safety and job performance.
- **ERGO VALVE** notation is directed at assessing the access and use of operating and maintenance valves with regard to accessibility and ease of identification and use.
- **ERGO MAINT** notation is directed at assessing the safety and ease of access to maintenance areas (maintenance platforms, access aids such as ladders, and the size of the maintenance workspace).

5 Process for Obtaining a Notation

5.1 Design Compliance Verification

Arrangement drawings, plans, and vessel design specifications for structures associated with these notations shall be prepared and submitted to ABS Engineering for review. For new construction, the drawings shall be provided to ABS Engineering during the detailed design phase. For existing vessels, the arrangement drawings and plans reflecting the current fittings and configurations shall be provided to and approved by ABS Engineering in advance of ABS Surveyor verifications.

Follow-up physical verification measurements of ergonomic criteria shall be performed by an ABS Surveyor. The ABS Surveyor shall select verification measurement sites.

5.2 Results

The ABS Engineering ergonomic assessment, and ABS Surveyor verification measurements, shall be reviewed by the ABS Surveyor for determination of notation confirmation.

6 Surveys after Construction

It is intended that all surveys after construction are to be aligned with Classification Surveys. Harmonization of surveys is to be carried out at the first available opportunity.

6.1 Annual Surveys *(1 September 2021)*

See 7-9-16/1 of the ABS *Rules for Survey After Construction (Part 7)*.

6.2 Requirements for Vessel Alterations *(1 September 2021)*

See 7-9-16/5 of the ABS *Rules for Survey After Construction (Part 7)*.

7 Alternatives+

7.1 General

ABS will consider alternative arrangements or criteria which can be shown to meet the intent of criteria directly cited or referred to in this Guide. The demonstration of an alternative's acceptability can be made through either the presentation of satisfactory service experience or systematic analysis based on valid engineering principles.

7.2 Other Regulations

ABS may consider for its acceptance, alternative arrangements and details which can be shown to comply with standards recognized in the country (flag State) in which the vessel is registered or operated, provided they are deemed not less effective.

7.3 Departures from Criteria

It is recognized that unusual or unforeseen conditions may lead to a case where one or more of the parameters of interest in granting a notation may temporarily fall outside the range of acceptability.

When a departure from criteria is identified during either the notation's initial issuance or reconfirmation process, it shall be reviewed by ABS in consultation with the Owner. When the ergonomic design contains departures from the stated criteria, these will be subject to special consideration upon the receipt of details about the departure. Depending on the degree and consequences of the departure, the shipyard or Owner may be required to provide an assessment and remediation plan to obtain or maintain the notation. Failure to complete the agreed remediation by the due date will lead to withdrawal of the notation.

SECTION 2

Documentation

1 Plans, Certifications, and Documentation

One set of the official (design and construction agents) electronic copies of the following plans and information shall be submitted to ABS Engineering for the purpose of review in the context of the **ERGO** notations being sought.

i) Details of arrangements of the components and structures appropriate for the notation(s) being sought.

ii) Diagrammed details of each of the above components and structures

iii) Any vendor documentation or certifications pertinent to applying the requirements to the design.

For new construction, the drawings shall be provided to ABS Engineering during the detailed design phase. For existing vessels, the arrangement drawings and plans reflecting the current configurations (e.g., topsides, below decks, etc.) shall be provided to, and approved by, ABS Engineering in advance of ABS Surveyor verifications.

ABS Engineering shall review the submitted accommodations documentation. ABS Engineering shall report any deviation from criteria to the Owner/shipyard for resolution and shall also identify any criteria that the ABS Surveyors must field-verify.

The ABS Surveyor shall verify that the submitted drawings match the constructed vessel. The ABS Surveyor shall also verify any criteria that are outstanding from the ABS Engineering review and document deviations from criteria.

SECTION 3
Notations

1 ERGO Notation Requirements

3/1 TABLE 1 “Requirements for each ERGO Notation” identifies the requirements applicable to the each of the offered notations. The presence of an ”x” in the table indicates the requirements section that applies to each notation.

TABLE 1
Requirements for each ERGO Notation

Requirements for Notations (See Section 4)	*Requirements Topic*	ERGO TOP	ERGO ES	ERGO VALVE	ERGO MAINT
4/1	Stairs	x	x		
4/2	Walkways and Ramps	x	x	x(1)	
4/3	Vertical and Inclined Ladders	x	x	x(1)	
4/4	Guard Rails and Climber Safety Devices	x	x	x(1)	x
4/5	Fall Protection from Secondary Fall Points	x	x		
4/6	Work Platforms	x	x	x(1)	x
4/7	Handles	x	x	x(1)	x
4/8	Hatches	x	x	x(1)	x
4/9	Doors and Scuttles	x	x	x(1)	x
4/10	Manual Valve Operation, Access, Location, and Orientation			x	x
4/11	Maintenance Access				x

Note:

1 Requirements imposed only when the ramp, ladder, platform, handles or other access is fitted for the purpose of valve access.

SECTION 4
Requirements for Notation(s)

1 Stairs

This Subsection contains requirements related to the design of stairs. The considerations listed below apply to the design of stairs and are not represented in the following figure and tables.

1.1 General

Following are general requirements for stairs:

i) Stairs are appropriate means for changing from one walking surface to another when the change in vertical elevation is greater than 600 mm (23.5 in.).

ii) Stairs shall be provided in lieu of ladders or ramps in accommodations spaces, office spaces, or to the navigation bridge.

iii) The angle of inclination shall be sufficient to provide the riser height and tread depth that follows, with a minimum angle of 38 degrees and maximum angle of 45 degrees.

iv) Stairs exposed to the elements shall have additional slip resistance due to potential exposure to water and ice.

v) Stairs shall be used in living quarters instead of inclined ladders.

vi) No impediments or tripping hazards shall intrude into the climbing spaces of stairs (for example, electrical boxes, valves, actuators, or piping).

vii) No impediments or tripping hazards shall impede access to stair landings (for example, piping runs over the landing or coamings/retention barriers).

1.2 Landings

1.2.1 Clear Landing

A clear landing at least as wide as the tread width and a minimum of 915 mm (36 in.) long shall be provided at the top and bottom of each stairway.

1.2.2 Intermediate Landing

An intermediate landing shall be provided at each deck level serviced by a stair, or a maximum of every 3500 mm (140 in.) of vertical travel for stairs with a vertical rise of 6100 mm (240 in.).

1.2.3 Change in Climb Direction

Any change of direction in a stairway shall be accomplished by means of an intermediate landing at least as wide as the tread width and a minimum of 915 mm (36 in.) long.

1.2.4 Maximum Angle of Inclination

Stairways shall have a maximum angle of inclination from the horizontal of 45 degrees.

1.2.5 Accommodating Stretchers

Where stairs change directions, intermediate landings along paths for evacuating personnel on stretchers shall be 1525 mm (60 in.) or greater in length to accommodate rotating the stretcher.

1.3 Stair Risers and Treads

Stair risers and treads shall have the following design, and see also 4/1.3 FIGURE 1, "Stair Step Riser and Tread Design":

i) A riser height shall be no more than 230 mm (9 in.) and a tread depth of 280 mm (11 in.), including a 25 mm (1 in.) tread nosing (step overhang)

ii) For stairs the depth of the tread and the height of riser shall be consistent

iii) Minimum tread width on one-way (where there is expected to be only one person transiting, ascending or descending stairway) stairs shall be at least 700 mm (27.5 in.)

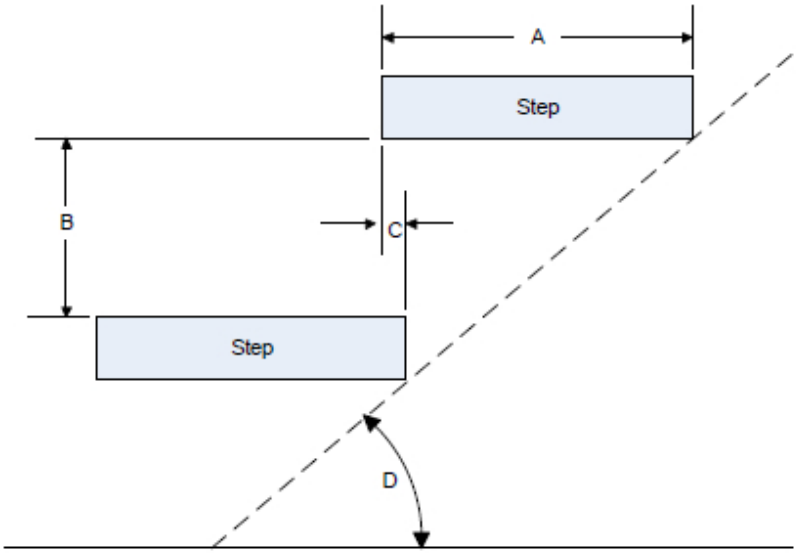
iv) Minimum tread width on two-way (where there may be two persons, ascending and descending, or passing in opposite directions) stairs shall be at least 900 mm (35.5 in.)

v) Once a minimum tread width has been established at any deck in that stair run, it shall not decrease in the direction of egress

vi) Nosings shall have a non-slip/skid surface that shall have a coefficient of friction (COF) of 0.6 or greater measured when wet.

FIGURE 1
Stair Step Riser and Tread Design

Dimension		*Requirements*
A	Tread Depth	280 mm (11.0 in.)
B	Vertical distance between steps	≤ 230 mm (9.0 in.)
C	Step overhang distance	25 mm (1.0 in.)
D	Steps angle of inclination	38 to 45 degrees



1.4 Headroom

Clear headroom (free height) maintained in all stairs shall be at least 2130 mm (84 in.).

1.5 Stair Handrails

Stair handrails shall be fitted as follows:

i) Stairs with three or more steps shall be provided with handrails as detailed in 4/1.5 TABLE 1, "Stair Handrail Arrangements".

ii) A single-tier handrail to maintain balance while going up or down the stairs shall be installed on the bulkhead side(s) of stairs.

iii) A two-tier handrail to maintain balance and prevent falls from stairs shall be installed on non-enclosed sides of stairs.

TABLE 1
Stair Handrail Arrangements

Arrangement	*Handrail Requirement*
1120 mm (44 in.) or wider stair with bulkhead on both sides	Single tier handrail on both sides
Less than 1120 mm (44 in.) stair width with bulkhead on both sides	Single tier handrail on one side, preferably on the right side descending.
1120 mm (44 in.) or wider stair, one side exposed, one with bulkhead	Two tier handrail on exposed side, single tier on bulkhead side
Less than 1120 mm (44 in.) stair width, one side exposed, one with bulkhead	Two tier handrail on exposed side
All widths, both sides of stairs exposed	Two tier handrail on both sides

1.6 Dimensions

i) Handrails shall be constructed with a circular cross section with a diameter of 40 mm (1.5 in.) to 50 mm (2.0 in.).

ii) Square or rectangular handrails shall not be fitted to stairs.

iii) The height of single tier handrails shall be 915 mm (36 in.) to 1000 mm (39 in.) from the top of the top rail to the surface of the tread.

iv) Two-tier handrails shall be two equally-spaced courses of rail with the vertical height of the top of the top rail 915 mm (36 in.) to 1000 mm (39 in.) above the tread at its nosing.

v) A minimum clearance of 75 mm (3 in.) shall be provided between the handrail and bulkhead or other obstruction.

2 Walkways and Ramps

This Subsection includes general principles as well as the design requirements for the arrangement of walkways and ramps and the provision of guardrails.

2.1 General Principles

The principles listed below apply to the design of walkways and ramps and are not represented in the following figures or tables.

i) Guard rails shall be provided at the exposed side of any walking or standing surface that is 600 mm (23.5 in.) or higher above the adjacent surface and where a person could fall from the upper to the lower surface.

ii) Ramps are used with changes in vertical elevations of less than 600 mm (23.5 in.).

iii) Ramps are provided with a non-skid surface that shall have a coefficient of friction (COF) of 0.6 or greater measured when wet.

iv) Headroom in all walkways shall be ≥ 2130 mm (84 in.).

v) Toeboards shall be provided on elevated walkways, platforms, and ramps.

vi) No impediments or tripping hazards shall intrude into the transit space (for example, electrical boxes, valves, actuators, or piping).

vii) No impediments or tripping hazards shall impede use of a walkway or ramp (for example, piping runs, hatch covers, deck impediments (e.g., through bolts) or combings/retention barriers).

2.2 Design Loads

The design loads listed in the following Subparagraphs are design load requirements for the **ERGO** notations. Where requirements for design loads, specified by other regulatory bodies (e.g., flag Administrations and port State authorities), are greater, those requirements take precedence over this Guide.

This Guide defines “design load" as the maximum intended load, being the total of all loads including the weight of the personnel, materials, and equipment, including the means of access structure.

2.2.1 Guardrails

Guardrails shall withstand anticipated loads but not less than 90 kg (200 lbs) at any point and in any direction when applied to the top rail.

2.2.2 Design Loads and Maximum Deflection

The minimum design loads for the walkways and ramps are:

i) 2.0 kN/m^2 (0.29 lbf/in^2) under uniform load for the structure, and

ii) 1.5 kN (337 lbf) concentrated load applied in the most unfavorable position over a concentrated load area of 200 mm × 200 mm (8 in. × 8 in.) for the flooring.

iii) When loaded with the design load, the deflection of the flooring shall not exceed 1/200th of the span and the difference between the loaded and adjacent unloaded flooring shall not exceed 4 mm in height.

2.3 Walkway Design

The dimensions relating to the design of walkways and ramps are presented in 4/2.3.2 FIGURE 2, "Walkway and Ramp Design".

2.3.1 Opening in Gratings

i) The maximum opening in a walkway grating under which the presence of persons is expected shall be less than 22 mm (0.9 in.).

ii) The maximum opening in a walkway grating under which the presence of persons is not expected shall be less than 35 mm (1.7 in.).

2.3.2 Toeboards

Toeboards shall have a height of 100 mm (4.0 in.) and have no more than a 6 mm (0.25 in.) clearance between the bottom edge of the toeboard and the walking surface.

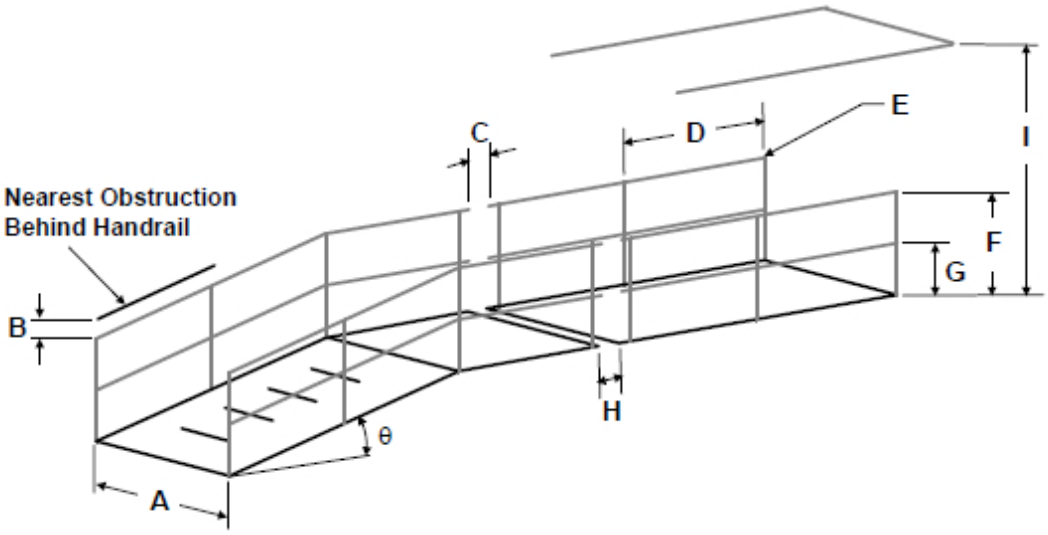
FIGURE 2
Walkway and Ramp Design(1)

Dimension		*Requirements*
A	Walkway width – one person (2)	≥ 710 mm (28 in.)
	Walkway width – two-way passage, or means of access or egress to an entrance	≥ 915 mm (36 in.)
	Walkway width – emergency egress, unobstructed width	≥ 1120 mm (44 in.)
B	Distance behind handrail and any obstruction	≥ 75 mm (3.0 in.)
C	Gaps between two handrail sections or other structural members	≤ 50 mm (2.0 in.)
D	Span between two handrail stanchions	≤ 2.4 m (8 ft)
E	Outside diameter of handrail	≥ 40 mm (1.5 in.) ≤ 50 mm (2.0 in.)
F	Height of handrail	1070 mm (42.0 in.)
G	Height of intermediate rail	500 mm (19.5 in.)
H	Maximum distance between the adjacent stanchions across handrail gaps	≤ 350 mm (14.0 in.)
I	Distance below any covered overhead structure or obstruction	≥ 2130 mm (84 in.)
θ	Ramp angle of inclination – unaided materials handling	≤ 5 degrees
	Ramp angle of inclination – personnel walkway	≤ 15 degrees

Notes:

1 Toeboard omitted for clarity.

2 The walkway width may be diminished to ≥ 500 mm around a walkway structure web frames.



3 Vertical and Inclined Ladders

This Subsection contains requirements related to the design of vertical and inclined ladders.

3.1 General

This Subsection contains requirements related to the design of the different attributes of vertical ladders, inclined ladders, and individual rung ladders. The requirements included in the figures and tables below provides the design and dimension requirements. Requirements related to topside stairs are provided in 4/1, “Stairs”.

The considerations listed below apply to the design of vertical and inclined ladders and are not represented in the following figures.

Vertical ladders, inclined ladders or ramps shall be provided whenever operators or maintainers must change elevation abruptly by more than 300 mm (12.0 in.). (Requirements relating to ramps are found in Section 4/2, “Walkways and Ramps”.) These structures, or a simple step, shall also be used for passage over low objects (e.g., pipes, lines, ridges).

Vertical ladders and inclined ladders hall be provided with skid/slip resistant on the rungs that shall have a coefficient of friction (COF) of 0.6 or greater measured when wet.

See 4/3.1 TABLE 2, "Inclination of Ladders" for requirements on angle of inclination.

TABLE 2
Inclination of Ladders

Dimension	*Requirements*
Inclined Ladders	45 to 60 degrees
Vertical Ladders	80 to 90 degrees

3.2 Design Loads

The design loads listed in the following Subparagraphs are design load requirements. However, if requirements for design loads specified by other regulatory bodies (e.g., flag Administrations and port State authorities) are more limiting, those requirements take precedence over this Guide.

This Guide defines "design load" as the maximum intended load, being the total of all loads including the weight of the personnel, materials, equipment and means of access structure, and shall be as follows:

i) Ladder handrails shall withstand anticipated loads but not less than 90 kg (200 lbs) at any point and in any direction when applied to the top rail.

ii) For vertical ladders, the design load shall be determined by the anticipated usage of the ladder, but shall not be less than a single concentrated live load of 90 kg (200 lbs). The weight of the ladder and attached appurtenances together with the design load shall be considered in the design of rails and fastenings.

iii) Inclined ladders shall be designed and constructed to carry a load of at least three times the normal load anticipated.

3.3 Vertical Ladders

3.3.1 General

General requirements for vertical ladders are:

i) Permanent vertical ladders shall be attached to a permanent structure.

ii) Fitted with a maximum distance from the ladder's centerline to any object that must be reached by personnel from the ladder shall not exceed 965 mm (38.0 in.).

iii) Located so as not to interfere with the opening and closing of hatches, doors, gratings, or other types of access.

iv) No impediments shall intrude into the climbing space (for examples, electrical boxes, valves, actuators, or piping).

3.3.2 Clearances

i) Overhead clearance above vertical ladder platforms shall be a minimum of 2500 mm (84.0 in.)

ii) There shall be at least 750 mm (29.5 in.) clearance in front of the ladder (climbing space).

iii) There shall be between 175 mm (7.0 in.) to 200 mm (8.0 in.) clearance behind the ladder (toe space).

3.4 Rung Design

i) Rungs shall be equally spaced along the entire flight of the ladder.

ii) If square bar is used for the rung, it shall be fitted to form a horizontal step with the edges pointing upward.

iii) Rungs shall also be carried through the side stringers and attached by double continuous welding.

iv) Ladder rungs shall be arranged so a rung is aligned with any platform or deck that an operator or maintainer will be stepping to or from.

3.5 Provision of Platforms

i) When the height of a vertical ladder exceeds 6.0 m (19.5 ft), an intermediate or linking platform shall be used.

ii) If a work task requires the use of two hands, working from a vertical ladder is not appropriate. The work area shall be provided with a work platform that provides a flat, stable standing surface.

3.6 Vertical Ladders as Means of Access

Where vertical ladders lead to manholes or passageways, horizontal or vertical handles or grab bars shall be provided. These shall extend at least 1070 mm (42.0 in.) above the landing platform or access/egress level served by the ladder. See also Section 4/7, “Handles”.

3.7 Vertical Ladder Design and Dimensions

The following figures present requirements for vertical ladders design and dimensioning:

- 4/3.7 FIGURE 3, “Vertical Ladders (General Criteria)”
- 4/3.7 FIGURE 4, “Staggered Vertical Ladder”
- 4/3.7 FIGURE 5, “Vertical Ladders to Landings (Side Mount)”
- 4/3.7 FIGURE 6, “Vertical Ladders to Landings (Ladder through Platform)”

FIGURE 3
Vertical Ladders (General Criteria)

Dimension		*Requirements*
A	Overhead Clearance	2130 mm (84.0 in.)
B	Ladder distance (gap accommodating toe space) from surface (at 90 degrees)	≥ 175 mm (7.0 in.) ≤ 200 mm (8.0 in.)
C	Horizontal Clearance (from ladder face and obstacles)	≥ 750 mm (29.5 in.) or ≥ 600 mm (23.5 in.) (in way of openings)
D	Distance between ladder attachments /securing devices	≤ 2.5 m (8.0 ft)
E	Ladder angle of inclination from the horizontal	80 to 90 degrees
F	Rung Design – (Can be round or square bar; where square bar is fitted, orientation shall be edge up)	Square bar mm (1.0 in.) × 25 mm (1.0 in.) Round bar mm (1.0 in.) diameter
G	Distance between ladder rungs (rungs evenly spaced throughout the full run of the ladder)	≥ 275 mm (11.0 in.) ≤ 300 mm (12.0 in.)
H	Skew angle	≤ 2 degrees
I	Stringer separation	400 to 450 mm (16.0 to 18.0 in.)
J	Ladder height: Ladders over 6 m (19.7 ft) require intermediate/linking platforms)	≤ 6.0 m (19.5 ft)

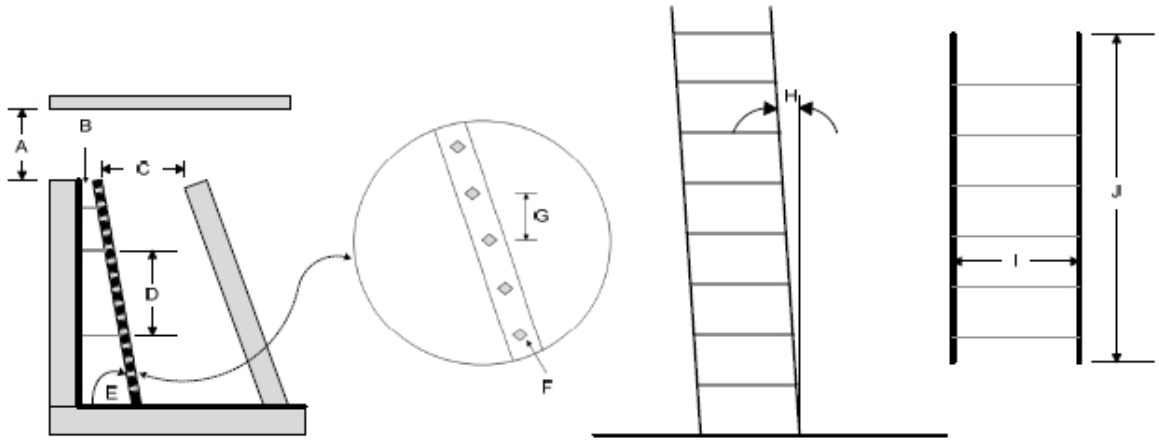


FIGURE 4
Staggered Vertical Ladder*

Dimension		*Requirements*
A	Stringer separation	400 to 450 mm (16.0 to 18.0 in.)
B	Horizontal separation between two vertical ladders, stringer to stringer	≥ 225 mm (9 in.) ≤ 450 mm (18 in.)
C	Distance between ladder rungs (rungs evenly spaced throughout the full run of the ladder)	≥ 275 mm (11.0 in.) ≤ 300 mm (12.0 in.)
D	Stringer height above landing or intermediate platform	≥ 1350 mm (53.0 in.)
E	Rung Design – (Can be round or square bar; where square bar is fitted, orientation shall be edge up)	Square bar 22 mm (0.9 in.) × 22 mm (0.9 in.) Round bar 25 mm (1.0 in.) diameter
F	Horizontal separation between ladder and platform	≥ 150 mm (6.0 in.) ≤ 300 mm (12.0 in.)
G	Landing or intermediate platform width	≥ 925 mm (36.5 in.)
H	Platform ladder to Platform ledge	≥ 75 mm (3.0 in.) ≤ 150 mm (6.0 in.)

* *Note:* Left side guardrail of platform omitted for clarity

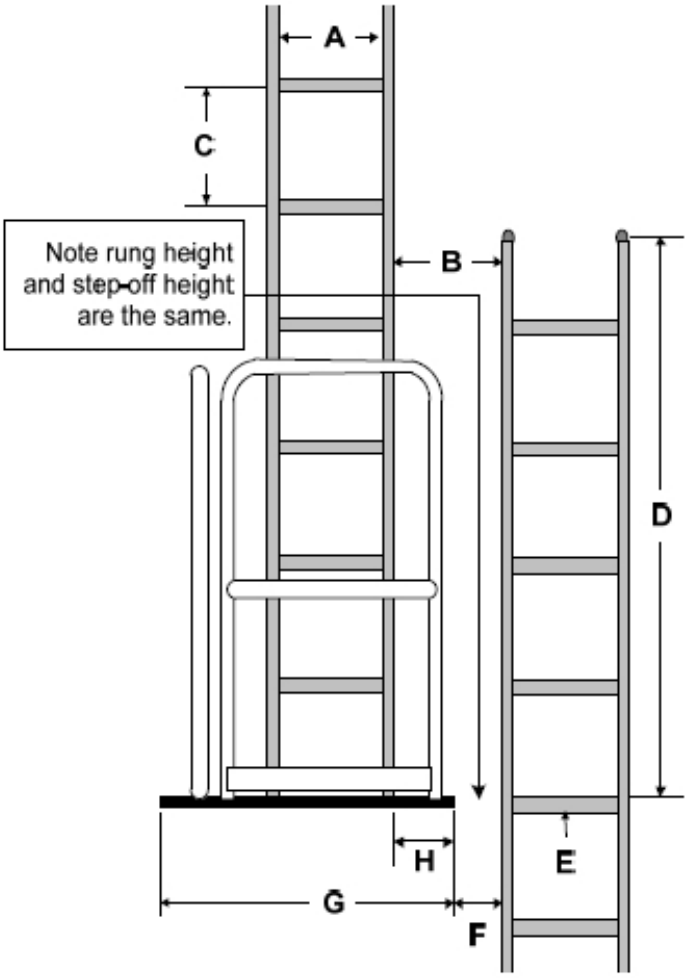


FIGURE 5
Vertical Ladders to Landings (Side Mount)*

Dimension		*Requirements*
A	Platform depth	≥ 750 mm (29.5 in.)
B	Platform width	≥ 925 mm (36.5 in.)
C	Ladder distance from surface	≥ 175 mm (7.0 in.)
D	Horizontal separation between ladder and platform	≥ 150 mm (6.0 in.) and ≤ 300 mm (12.0 in.)

* *Notes:* Top view. Guardrails/Handrails not shown.

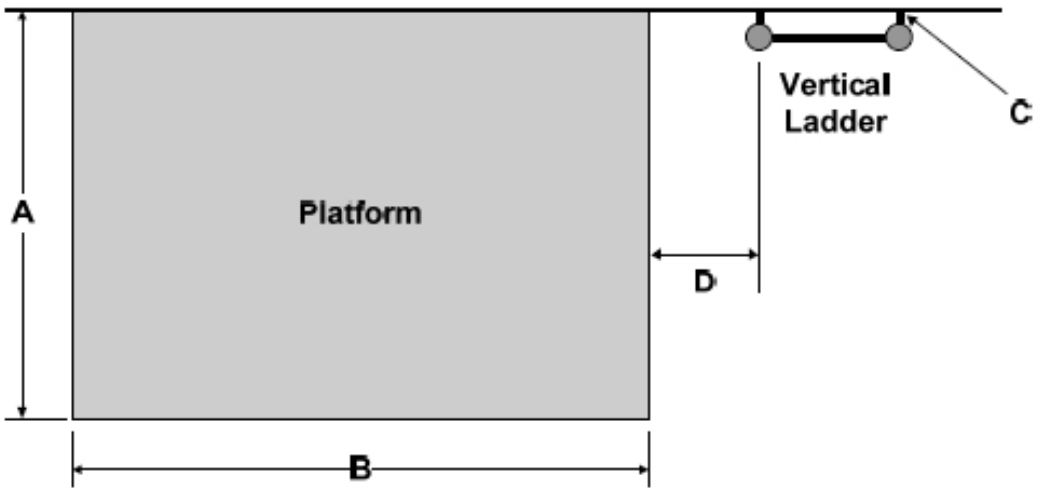
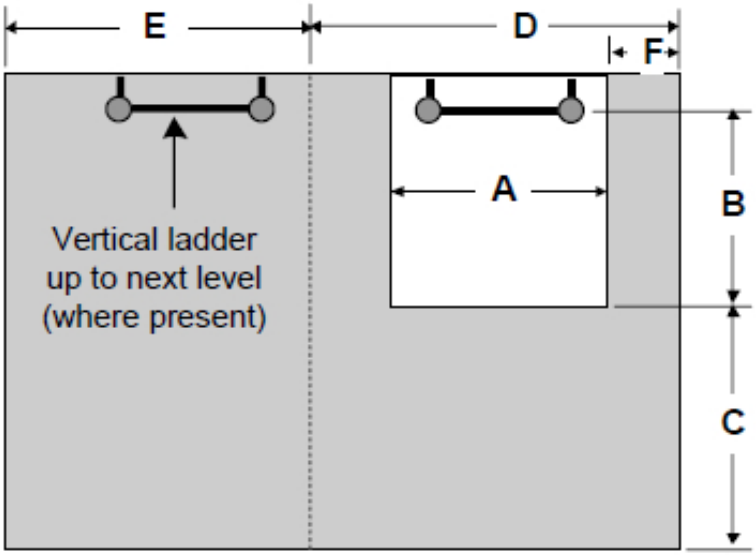


FIGURE 6
Vertical Ladders to Landings (Ladder through Platform)*

Dimension		*Requirements*
A	Vertical ladder opening	≥ 750 mm (29.5 in.)
B	Distance from front of vertical ladder to back of platform opening	≥ 750 mm (29.5 in.)
C	Minimum clear standing area in front of ladder opening – Depth	≥ 750 mm (29.5 in.)
D	Minimum clear standing area in front of ladder opening – Width	≥ 925 mm (36.5 in.)
E	Additional platform width for intermediate landing (where present)	≥ 925 mm (36.5 in.)
F	Horizontal separation between ladder and platform	≥ 150 mm (6.0 in.) and ≤ 300 mm (12.0 in.)

* *Notes:* Top view. Guardrails/Handrails not shown



3.8 Individual Rung Ladders

The requirements listed below apply to individual rung ladders and are not represented in the following figure.

i) Individual rungs may be attached directly to a bulkhead, tank or steel structure and used as a vertical ladder, but shall be limited to changes in vertical elevation of 3.6 m (12.0 ft) or less.

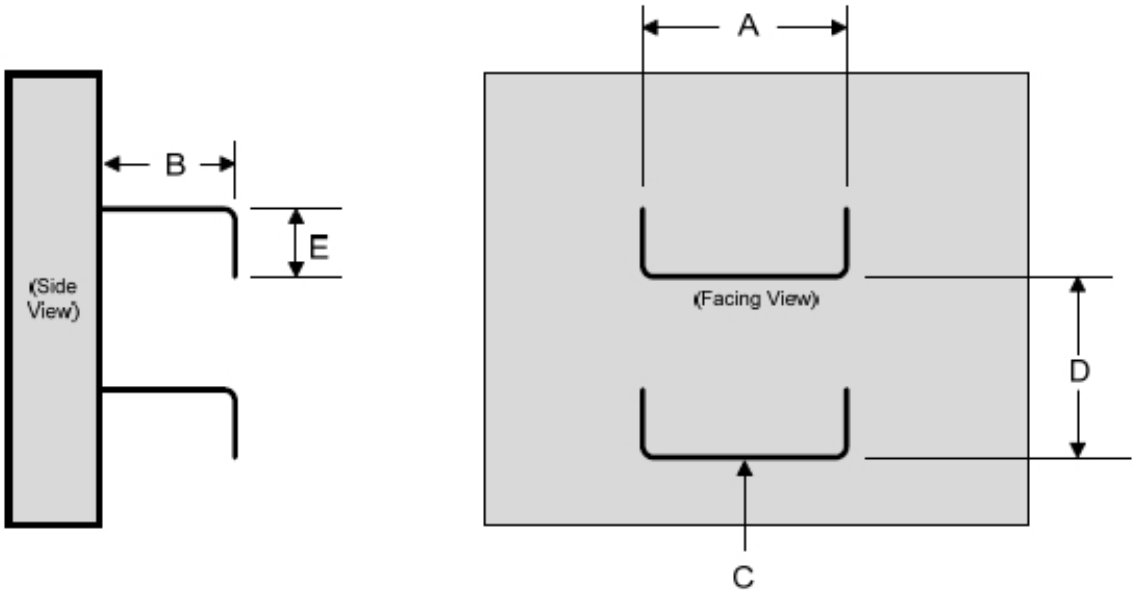
ii) Each rung shall be attached to the structure in a manner that fully supports a climber and any design loads.

iii) Rungs shall be provided with lateral support for the foot.

Individual rung ladder design is presented in 4/3.8 FIGURE 7, “Individual Rung Ladder Design.”

FIGURE 7
Individual Rung Ladder Design

Dimension		*Requirements*
A	Rung width	≥ 400 mm (16.0 in.) ≤ 450 mm (18.0 in.)
B	Rung depth	≥ 175 mm (7.0 in.) ≤ 200 mm (8.0 in.)
C	Rung Design – (Can be round or square bar; where square bar is fitted, orientation shall be edge up)	Square bar 22 mm (0.9 in.) × 22 mm (0.9 in.) Round bar 25 mm (1.0 in.) diameter
D	Distance between ladder rungs (rungs evenly spaced throughout the full run of the ladder)	≥ 275 mm (11.0 in.) ≤ 300 mm (12.0 in.)
E	Height of foot slip protection	50 mm (2.0 in.)



3.9 Inclined Ladders

3.9.1 General

Inclined ladders shall be attached to a permanent structure.

i) Where inclined ladders change directions and are used to carry personnel on stretchers, intermediate landings along paths shall be 1525 mm (60.0 in.) in length to accommodate rotating a stretcher.

ii) Inclined ladders and handrails shall be located so as not to interfere with the opening and closing of hatches, doors, gratings or manholes.

iii) No impediments shall intrude into the climbing space (for example, electrical boxes, valves, actuators, or piping).

3.9.2 Tread/Step Design

i) Steps shall be equally spaced along the entire flight of the inclined ladder.

ii) Square bar, round bar, or full steps can be used to form the step. Where square bar is used, treads/steps shall be fitted with an edge pointing upward. Where full steps are use, the steps shall be parallel to the deck surface.

iii) These steps shall also be carried through the side stringers and attached by double continuous welding.

3.9.3 Handrail Design

Handrail design loads are presented in 4/3.2, “Design Loads”.

i) Handrails shall be constructed with a circular cross section with a diameter of 40 mm (1.5 in.) to 50 mm (2.0 in.).

ii) A clearance of at least 75 mm (3.0 in.) shall be provided between the handrail and bulkhead or other obstruction.

3.9.4 Inclined Ladder Design

The following figures present requirements for inclined ladder design and dimensioning:

- 4/3.9.4 FIGURE 8, “Inclined Ladders”
- 4/3.9.4 FIGURE 9, “Inclined Ladders with Landings”
- 4/3.9.4 FIGURE 10, “Inclined Ladder Landing/Platform”

FIGURE 8
Inclined Ladders

Dimension		*Requirements*
A	Handrail/guardrail diameter	≥ 40 mm (1.5 in.) to ≤ 50 mm (2.0 in.)
B	Handrail/guardrail height (from leading edge of tread)	≥ 915 mm (36.0) and ≤ 1000 mm (39.0 in.)
C	Tread/step spacing – equally spaced along entire ladder	≥ 200 mm (8.0 in.) and ≤ 300 mm (12.0 in.)
D	Step depth Use of square bar is optional	≥ 100 mm (4.0 in.)
E	Handrail/guardrail to handrail width	≥ 450 mm (18.0 in.) ≤ 560 mm (22.0 in.)
F	Angle of inclination	45 to 60 degrees

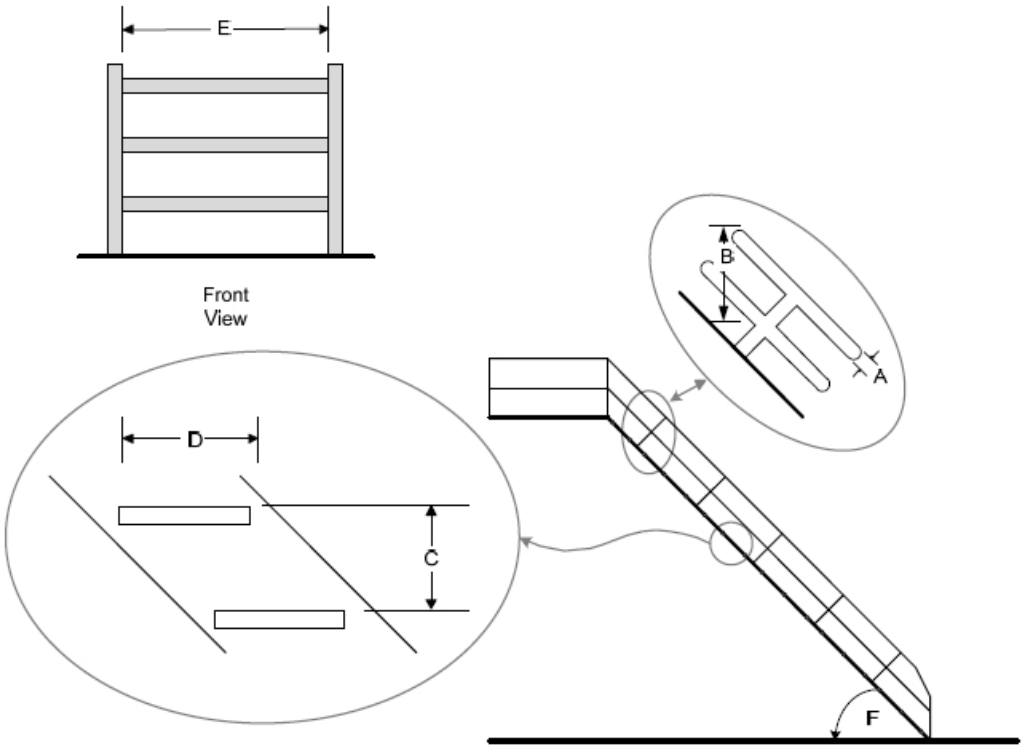


FIGURE 9
Inclined Ladders with Landings

Dimension		**ERGO TOP**
A	Overhead Clearance	2130 mm (84.0 in.)
B & C	Maximum continuous height	≤ 6 m (19.7 ft)
D	Deck to lower landing level	≥ 2.5 m (8.2 ft)
E	Height of intermediate rail	535 mm (21.0 in.)
F	Height of top rail	535 mm (21.0 in.)
G	Landing/Platform dimensions	See 4/3.9.4 FIGURE 10, "Inclined Ladder Landing/ Platform"
H	Vertical obstruction height above ladder	2030 mm (80 in.)
I	Height of rail around platform	1070 mm (42.0 in.)
J	Stringer height (ladder) above landing or intermediate platform	≥ 1350 mm (53.0 in.)
K	Angle of inclination	45 to 60 degrees

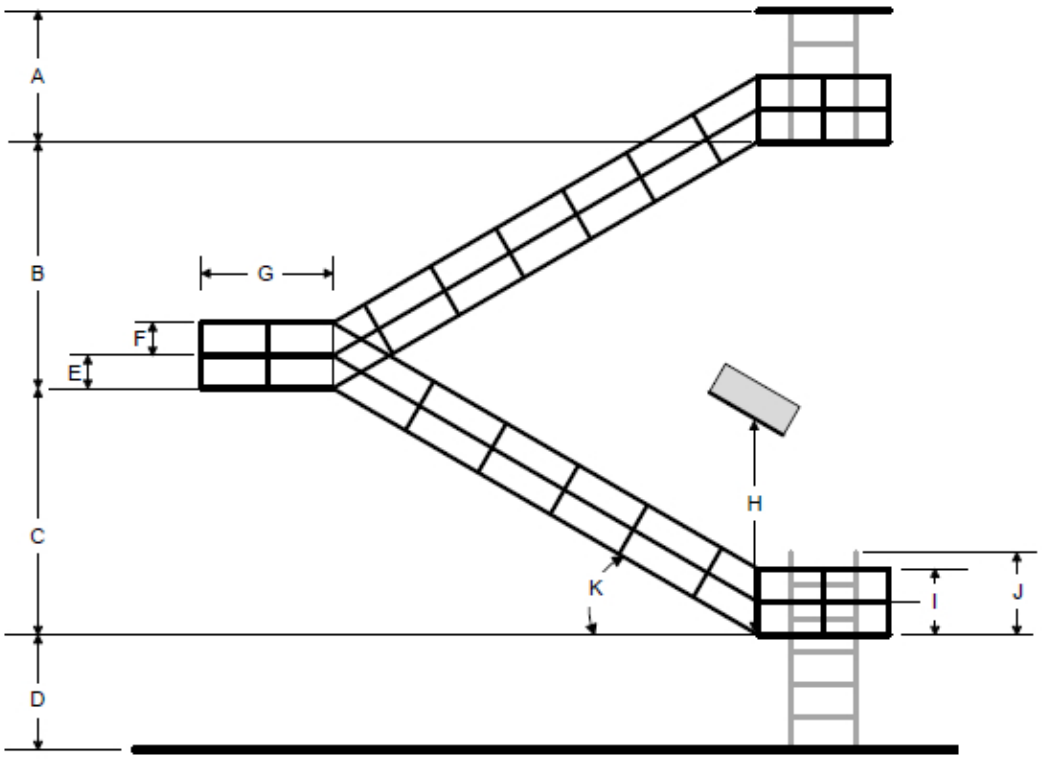
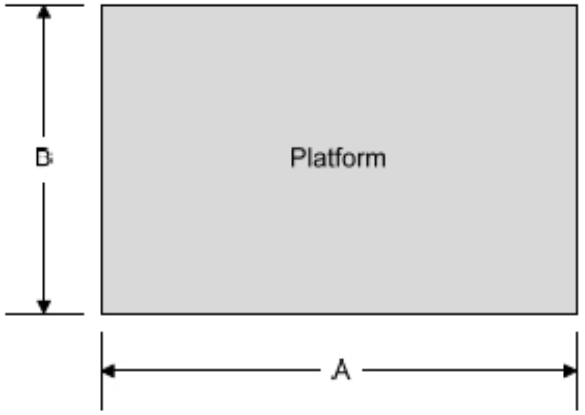


FIGURE 10
Inclined Ladder Landing/Platform*

Dimension		*Requirements*
A	Minimum landing length	≥ 975 mm (38.5 in.)
B	Minimum landing width/depth	600 mm (23.5 in.) for the last flight of inclined ladder. If landing is used to access another inclined ladder flight, then the landing width shall be at least twice the width of the inclined ladder.

* *Notes:* Top view. Guardrails/Handrails not shown.



4 Guard Rails and Climber Safety Devices

This Subsection includes general principles as well as the design requirements for the design and arrangement of handrails, climber safety devices for fall protection, whether by active protection (safety rails and harnesses) or passive protection (safety cages). These requirements include:

i) Height and diameter of handrails

ii) Span and gap between handrail stanchions

iii) Distance between handrail and any obstruction

iv) Intermediate rails

v) Climber safety equipment

4.1 General Principles

The principles listed below apply to the design of walkways and ramps and are not represented in the following figures or tables.

i) Handrails/guardrails shall be provided at the exposed side of any walking or standing surface that is 600 mm (23.5 in.) or higher above the adjacent surface and where a person could fall from the upper to the lower surface.

ii) Where stays are provided for supporting stanchions, they shall be fitted so as not to obstruct safe passage.

iii) Stanchion scantlings can be formed of flat or round bar. See 4/2.3.2 FIGURE 2, "Walkway and Ramp Design".

iv) The top handrail shall be round bar or tube.

v) Brackets joining the guardrail stanchions to the means of access shall be oriented in a way to avoid causing a trip hazard (e.g., parallel to direction of the walkway).

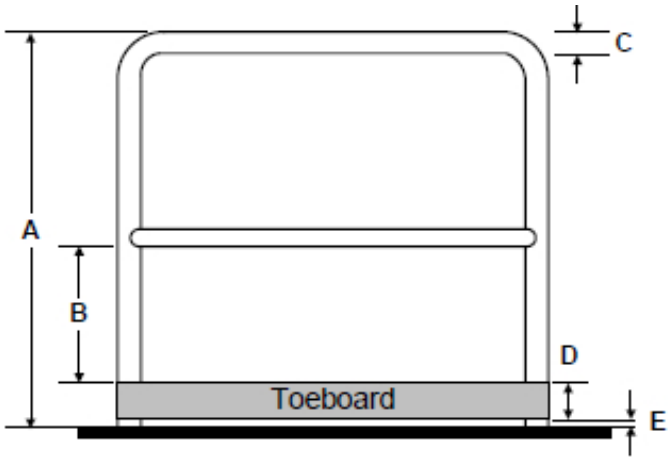
Means shall be provided for deicing of guard rails and climber safety devices.

4.2 Handrail Dimensions with a Toeboard

Requirements for handrail dimensions and associated toeboard are presented in 4/4.2 FIGURE 11, "Handrail/Guardrail Dimensions with a Toeboard"

FIGURE 11
Handrail/Guardrail Dimensions with a Toeboard

Dimension		*Requirements*
A	Height of handrail/guardrail	1070 mm (42.0 in.)
B	Height of intermediate rail above toeboard	425 mm (16.75 in.)
C	Outside diameter of handrail	40 mm (1.5 in.) to 50 mm (2.0 in.)
D	Height of toeboard	100 mm (4.0 in.)
E	Gap between toeboard and surface	6 mm (0.25 in.)



4.3 Provision of Safety Railings

4.3.1 Railings

Rails shall be installed parallel to the deck along deck edges and walkways and around open hatches, elevators, working platforms and along other boundaries in the following areas:

i) Wherever there is danger of operators or maintainers falling to a lower level of ≥ 600 mm (23.5 in.)

ii) Wherever there is danger of operators or maintainers becoming enmeshed with operating machinery

iii) Around openings with a coaming height below 760 mm (30 in.)

Note:

Temporary rails can be used around unprotected opening into which a person may slip, trip or fall.

4.3.2 Storm Rails

Suitable storm rails/handrails shall be provided in all interior passageways where persons onboard might have normal access:

i) Storm rails/handrails shall be installed on both sides of passageways that are 1830 mm (72 in.) or more in width

ii) Storm rails/handrails shall be 865 mm (34 in.) to 965 mm (38 in.) high

The distance between storm rails/handrails and any obstruction is 75 mm (3 in.) or greater.

4.4 Deck Edge, Elevated Walkway Railing Design

Deck edge and elevated walkway railings shall have the following design (see 4/4.4 FIGURE 12, "Deck Edge and Elevated Walkway Rail Dimensions"):

i) The heights of rails or bulwarks shall be at least 1070 mm (42 in.) from the deck.

ii) Rail courses or equivalents shall be installed between a top rail and the deck so that the opening below the lowest course does not exceed 230 mm (9 in.) and the distance between the remaining courses is not more than 380 mm (15 in.).

iii) Toeboards shall be at least 100 mm (4.0 in.) in height and have no more than a 6 mm (0.25 in.) clearance between the bottom edge of the toeboard and the walking surface.

iv) Vertical stanchions for railings shall be spaced no more than 1525 mm (60 in.) apart horizontally.

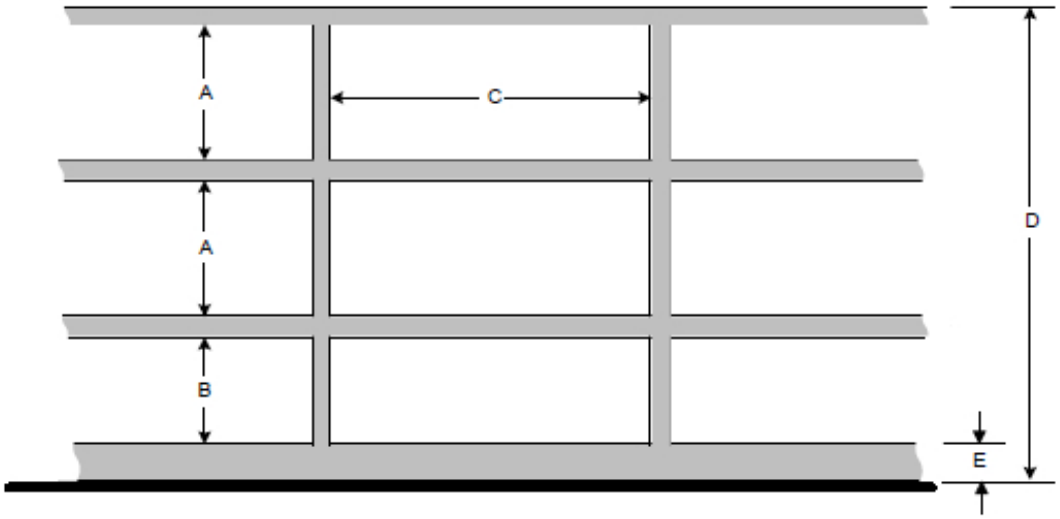
v) At least every third vertical stanchion shall be supported by a bracket or stay.

vi) Chain or wire rope shall not be used as a deck edge or elevated walkway rail.

FIGURE 12
Deck Edge and Elevated Walkway Rail Dimensions

Dimension		*Requirements*
A	Upper rail courses vertical separation	≤ 380 mm (15 in.)
B	Lower rail course vertical separation	≤ 230 mm (9 in.)
C	Vertical stanchion separation	≤ 1525 mm (60 in.)
D	Rail height from deck to top of rail*	≥ 1070 mm (42 in.)
E	Toeboard height	100 mm (4.0 in.)

* *Note:* Assumes Guardrail diameter of 50 mm (2 in.).



4.5 Safety Cages

Below are requirements related to climber safety cage design:

i) Cages shall be used on vertical ladders over 4.5 m (15.0 ft) in height.

ii) Climber safety rails or cables shall be used on vertical ladders in excess of 6.1 m (20.0 ft).

iii) Requirements for the construction of the safety cage is shown in 4/4.5 FIGURE 13, "Arrangement for Cage of Vertical Ladder" and 4/4.5 FIGURE 14, "Cage of Vertical Ladder – Side View".

iv) Cages shall extend 1400 mm (54 in.) above the top-landing surface.

v) Cages equipped with intermediate landings shall extend 1400 mm (54 in.) above the intermediate landing with the cage open on the side facing the landing.

vi) Safety cages shall be provided for ladders ≤ 4.5 m (15.0 ft) in height where a fall to a level or deck below the ladder base is possible (e.g., within 1825 mm (72 in.) of the edge of a deck).

FIGURE 13
Arrangement for Climber Safety Cage of Vertical Ladder

Dimension		*Requirements**
A	Distance from centerline of ladder rung to point of radius of the safety cage horizontal guards	350 mm (14.0 in.)
B	Horizontal guard radius	Horizontal guard at bottom of cage – 425 mm (17.0 in.)
		All other horizontal guards – 350 mm (14.0 in.)
C	Vertical separation of horizontal guard placement	≤ 1200 mm (47.0 in.)

* *Note:* Or meet flag State standards.

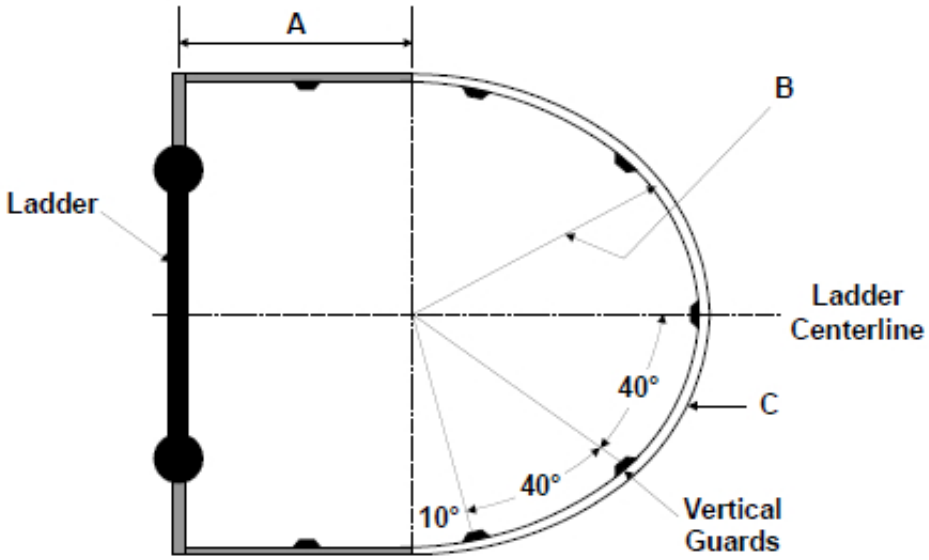
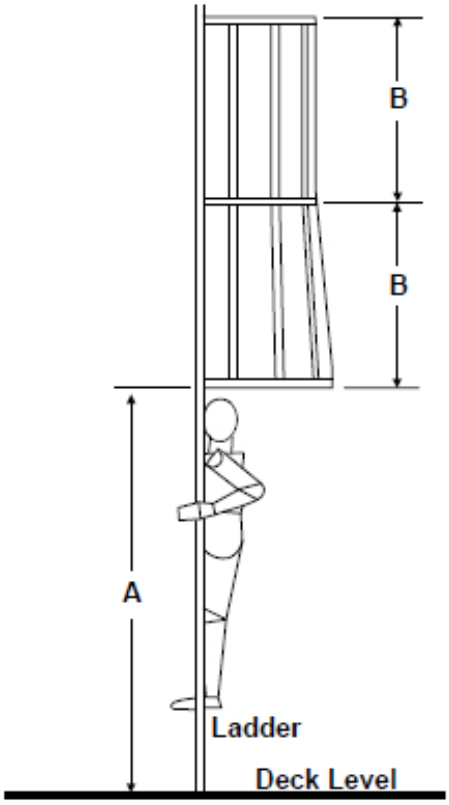


FIGURE 14
Climber Safety Cage of Vertical Ladder – Side View

Dimension		*Requirements*
A	Distance above standing surface	≥ 2200 mm (87.0 in.) ≤ 2500 mm (98.0 in.)
B	Vertical separation of horizontal guard placement	≥ 1140 mm (45.0 in.) ≤ 1220 mm (48.0 in.)



4.6 Climber Safety Rails or Cables

Listed below are requirements related to the use of climber safety rails or cables, where provided.

i) A climber safety rail or cable shall be installed at each permanently installed topside ladder on masts, kingposts and other similar topside structures providing access to fall hazard locations.

ii) Climber safety rail shall be stainless steel flat bar and equipped with two safety slides, which can be attached to the flat bar or cable.

iii) If climber safety devices are used, the ladder stringers at a top landing shall be designed to allow personnel to access any associate landing without unfastening (See 4/4.6 FIGURE 15, "Ladders with Climber Safety Rails or Cables").

FIGURE 15
Ladders with Climber Safety Rails or Cables(1)

Dimension		*Requirements* (2)
A	Distance to bottom of climber safety rail	≥ 900 mm (35.5 in.) ≤ 950 mm (37.5 in.)
B	Inside clearance(3) (ladder rungs)	225 mm (9.0 in.) 250 mm (10.0 in.)
C	Inside clearance(3) (upper hand rails)	380 mm (15.0 in.)

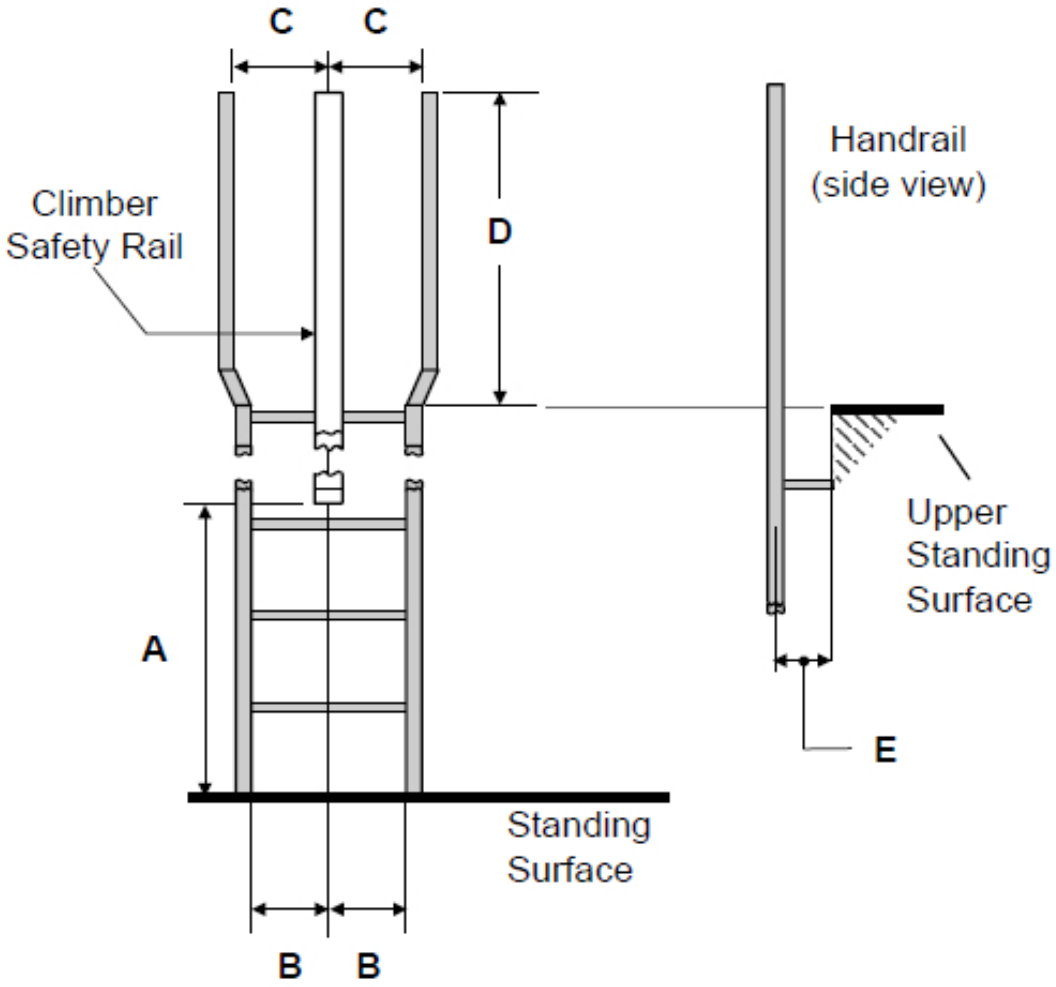
D	Top of climber safety rail and handrail height above upper standing surface	≥ 1070 mm (42.0 in.)
E	Distance from opposing vertical surface	≥ 175 mm (7.0 in.) ≤ 200 mm (8.0 in.)

Notes:

1 No safety cage provided.

2 Dimensions differ from other ladder types as the presence of the safety rail and the wearing of climber harnesses changes the ergonomic requirements imposed on the design.

3 Stringer separation increased to accommodate width of climber safety device.



4.7 Safety Drop Bars

All fixed ladders serving elevations 760 mm (30 in.) or more above ground, platform, or floor level shall be equipped with drop bars or safety gates. Drop bars shall be attached as follows:

i) Side access ladders shall hinge at the ladder side.

ii) Front access ladders shall hinge at the right when facing the ladder from the platform side

iii) Drop bars shall not be placed beyond the outer edge of the platform.

iv) Chains shall not be used in lieu of a drop bar.

4.8 Safety Gates

Where a self-closing safety gate is provided, the following shall apply:

i) The self-closing safety gate shall be installed at the top of each ladder and shall cover the full width of the opening between the ladder stringers.

ii) The gate shall open away from the person climbing up the ladder.

iii) Safety gates shall be sufficiently robust to resist the full weight of a 90 kg (200 lbs) person in both the vertical and horizontal direction.

iv) Chains shall not be used in lieu of a safety gate.

5 Fall Protection from Secondary Fall Points

5.1 General

Vertical ladders shall not be located within 1.83 m (6 ft.) of other nearby potential fall points (including the deck edge, cargo holds, and lower decks) without additional fall protection, such as guardrails.

Additional fall protection shall be provided for the ladder climber for the case:

i) If a vertical ladder (of any height) is located within 1.83 m (6 ft) of another and nearby potential (secondary) fall point (for example overboard or to a lower deck or landing),

and

ii) If thepotential fall distance is greater than 4.600 m (15 ft). (The potential fall distance is the height of the ladder plus the height of the secondary fall),

and

iii) If no active fall protection is fitted to the ladder (a safety cage is not considered to provide active protection),

then

iv) Additional fall protection to the ladder climber shall be provided, regardless of whether a climber safety cage is fitted to the ladder, as described in 4/5.2.

Note:

Passive Fall Protection is a safety design or device that requires a person to take no specific action prior to a potential loss, for example, a safety cage permanently fitted to a ladder.

Active Fall Protection is a safety design or device that actively (or directly) requires a person to take specific actions before a potential loss, for example, donning a fall arrestor fitted to both the ladder and the climber.

5.2 General Principles

5.2.1 Protection for Vertical Ladders without Safety Cages or Climber Safety Rails/Cables

The following shall apply to vertical ladders less than of 4.5 m (15.0 ft) that are not fitted with a safety cage or a safety rail.

Guardrail requirements are found in the following:

i) 4/5.2.1 TABLE 3, "Guardrail Requirements for Vertical Ladders without Safety Cages or Climber Safety Rails/Cables", provides the dimensions for requirements to guardrails near the base of the ladder.

ii) 4/5.2.1 FIGURE 16, "Front View of Guardrail Requirements for Vertical Ladders without Safety Cages or Climber Safety Rails/Cables" and 4/5.2.1 FIGURE 17, "Side View of Guardrail Requirements for Vertical Ladders with or without Safety Cages or Climber Safety Rails/Cables", provide dimensions and graphical representations.

Other designs and arrangements that serve to protect personnel from falls may also be deemed to be acceptable.

TABLE 3
Guardrail Requirements for Vertical Ladders without Safety Cages or Climber Safety Rails/Cables

Dimension	*Requirement**
Height of vertical guardrail	Height shall extend to within 760 mm (30 in.) of the top of the ladder.
Width of vertical guardrail	Protection shall be provided for a minimum of 1220 mm (48 in.) on each side of the centerline of the ladder, space permitting.
Distance between guardrail courses or tiers	A maximum of 460 mm (18 in.) shall be provided between guardrail courses or tiers of the guardrail extension. The measurement shall be taken from the course or tier' s outside diameter to outside diameter as shown in Section 4, Figure 16.

* *Note:* If the vertical ladder is movable (e.g., can rotate because it is mounted on the side of a crane cab), the height of the vertical guardrail shall continue horizontally to a distance of 600 mm (23.5 in.) from each side of the centerline of the movable object when it is at its travel limits.

FIGURE 16
Front View of Guardrail Requirements for Vertical Ladders without Safety Cages or Climber Safety Rails/Cables

Dimension		*Requirements**
A	Horizontal spacing between ladder centerline and rail end	≥ 1220 mm (48.0 in.)
B	Vertical distance from top of ladder to top of rail	≤ 760 mm (30.0 in.)
C	Spacing between top rail and mid-rail	≤ 380 mm (15.0 in.)
D	Height of toeboard	100 mm (4.0 in.)

* *Note:* Vertical ladder requirements apply. (See 4/3.3, "Vertical Ladders")

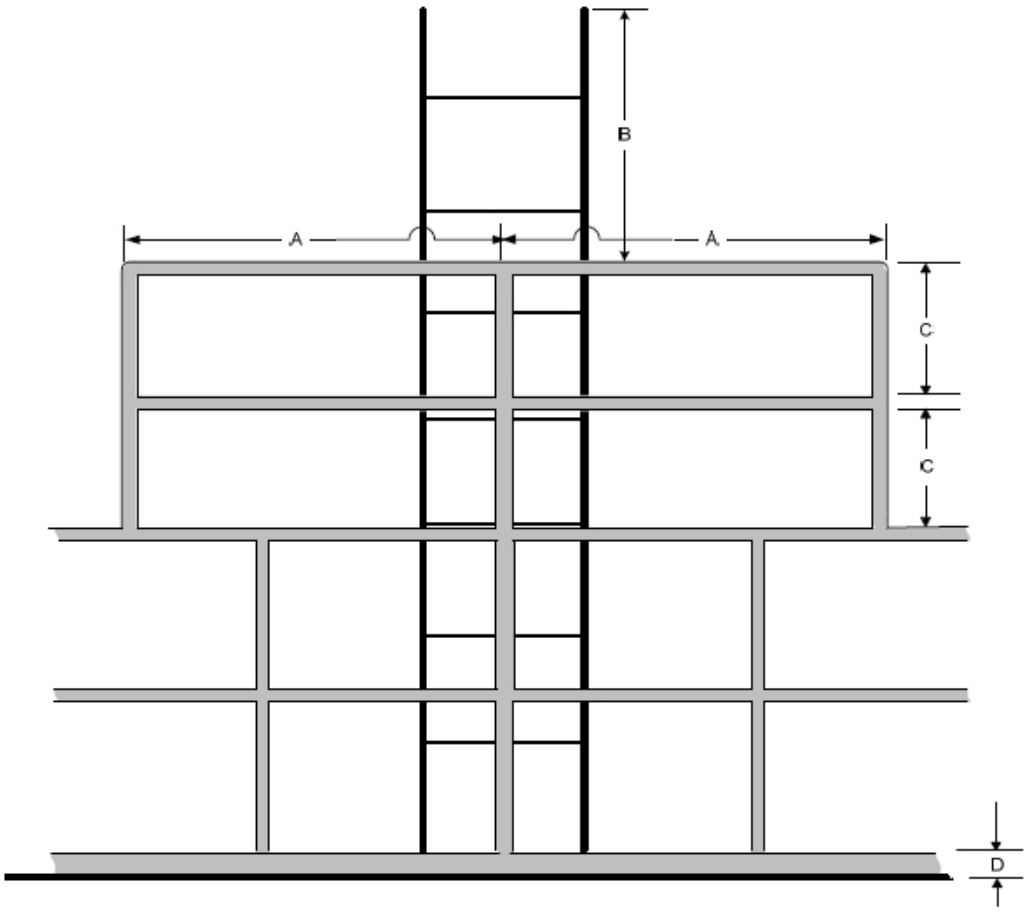
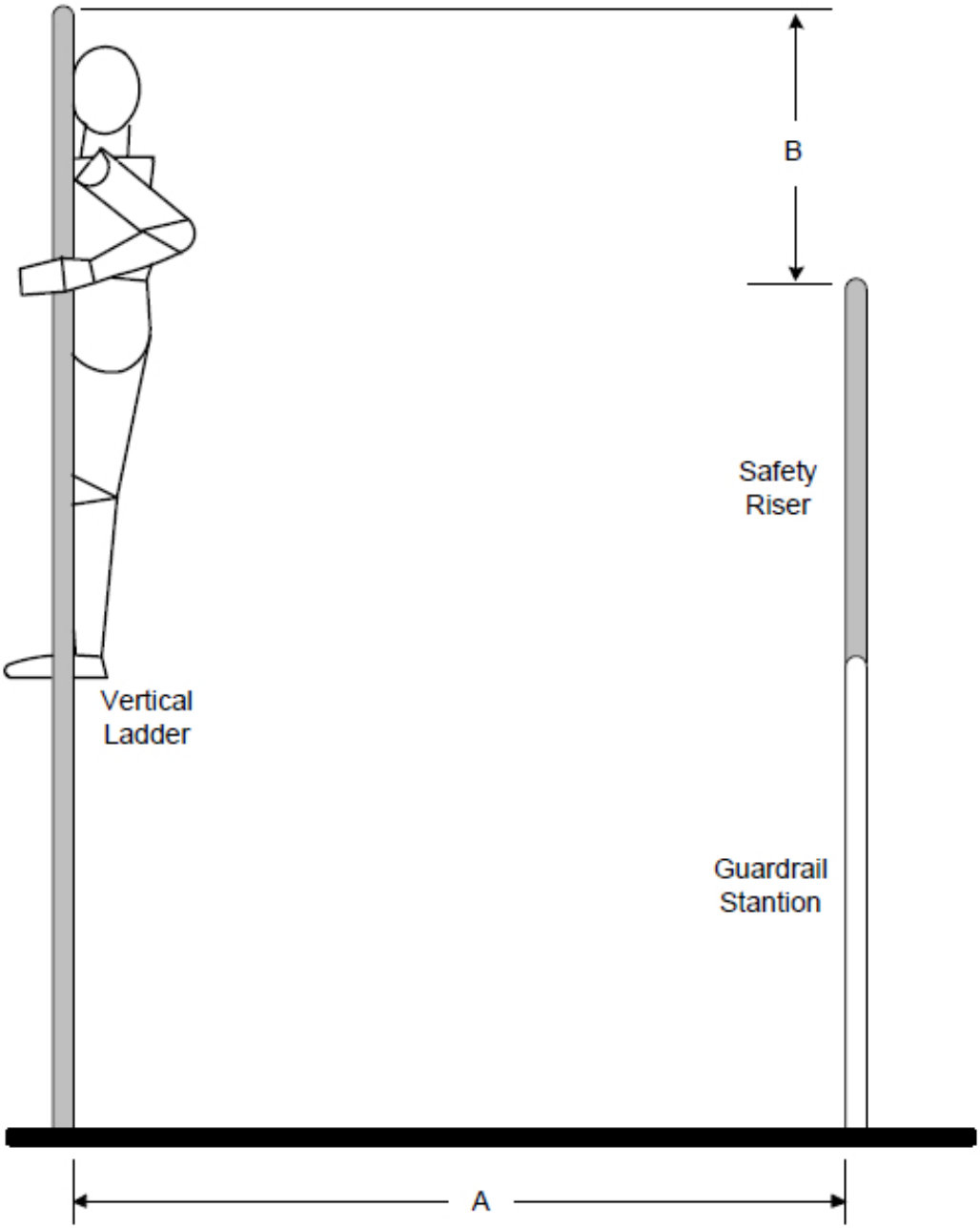


FIGURE 17
Side View of Guardrail Requirements for Vertical Ladders without Safety Cages or Climber Safety Rails/Cables

Dimension		*Requirements*
A	Horizontal distance between ladder and rails	≤ 1830 mm (72.0 in.)
B	Vertical distance from top of rail to top of ladder	≤ 760 mm (30 in.)



5.2.2 Protection for Vertical Ladders with Safety Cages and without Climber Safety Rails/ Cables

i) Guardrail requirements are found in the following: 4/5.2.2 TABLE 4, "Guardrail Requirements for Vertical Ladders with Safety Cages and without Climber Safety Rails or Cables", provides requirements for guardrails near the base of the ladder.

ii) 4/5.2.2 FIGURE 18, "Front View of Guardrail Requirements for Vertical Ladders with Safety Cages and without Climber Safety Rails or Cables", provides dimensions and graphical representations. Note that Dimension A of 4/5.2.2 FIGURE 18 also applies to

Guardrail Requirements for Vertical Ladders with Safety Cages and without Climber Safety Rails or Cables.

Other designs and arrangements that serve to protect personnel from falls may also be deemed to be acceptable.

TABLE 4
Guardrail Requirements for Vertical Ladders with Safety Cages and without Climber Safety Rails or Cables

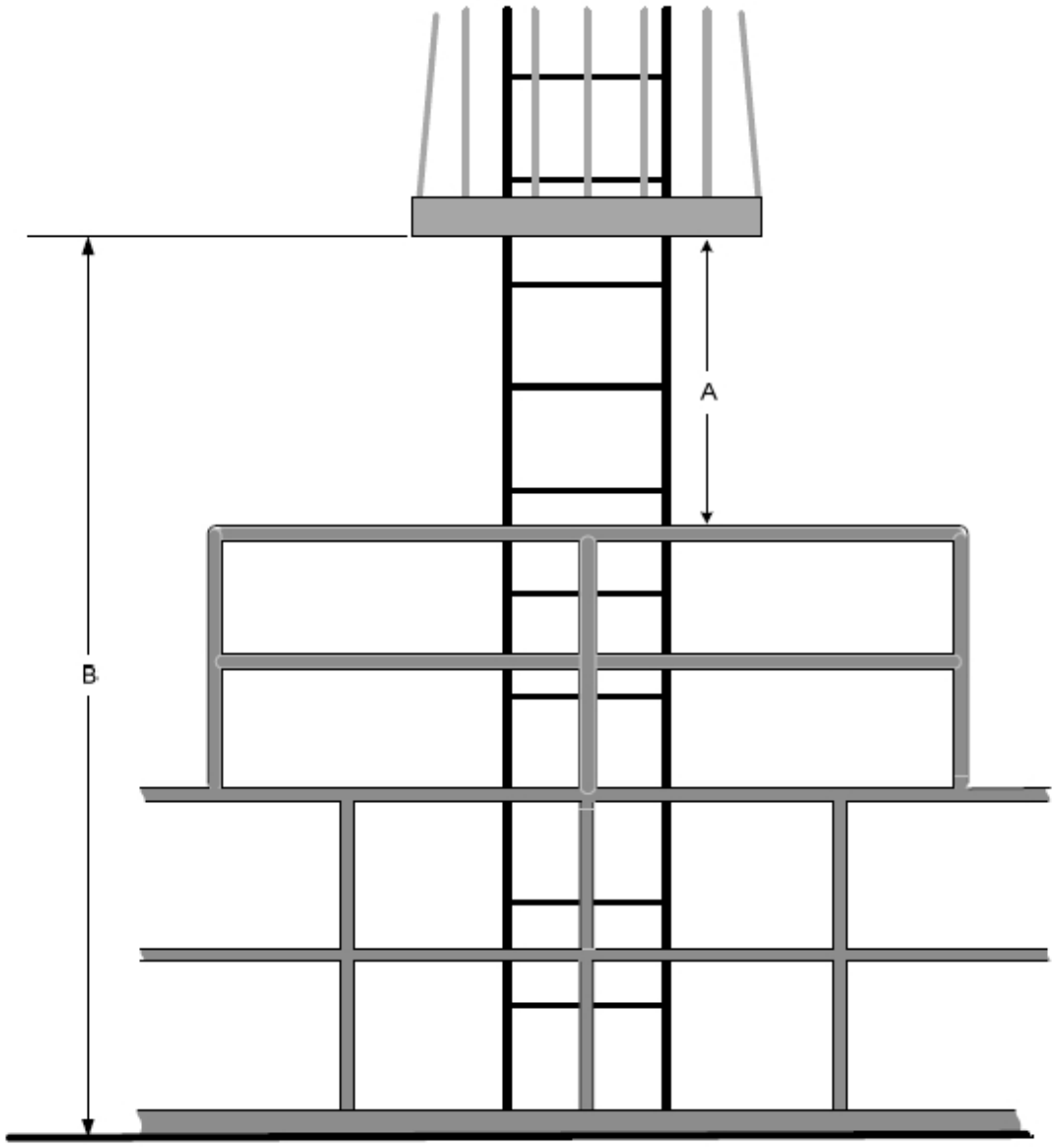
Dimension	*Requirement**
Height of vertical guardrail	The height shall extend to within 760 mm (30 in.) of the lower edge of the safety cage
Width of vertical guardrail	Protection shall be provided for a minimum of 1220 mm (48 in.) on each side of the centerline of the ladder, space permitting.
Distance between guardrail extension courses or tiers	A maximum of 460 mm (18 in.) shall be provided between guardrails courses or tiers of the guardrail extension. The measurement shall be taken from the course or tier outside diameter to outside diameter as shown in 4/5.2.1 FIGURE 16.
Horizontal distance between ladder and rails	1830 mm (72.0 in.) (Refer to Dimension A of 4/5.2.1 FIGURE 17, “Side View of Guardrail Requirements for Vertical Ladders without Safety Cages or Climber Safety Rails/Cables”)

* *Note:* If the vertical ladder is movable (e.g., can rotate because it is mounted on the side of a crane cab), the height of the vertical guardrail shall continue horizontally to a distance of 600 mm (23.5 in.) from each side of the centerline of the movable object when it is at its travel limits.

FIGURE 18
Front View of Guardrail Requirements for Vertical Ladders with Safety Cages and without Climber Safety Rails/Cables*

Dimension		*Requirements*
A	Vertical distance between safety cage and rail	≤ 760 mm (30.0 in.)
B	Vertical distance between the safety cage and platform	2130 mm (84.0 in.)

* *Note:* Assumes that the potential fall distance is greater than 4575 mm (15 ft.) where a safety cage, but no climber safety rail or cable is present



5.2.3 Guardrail Requirements for Movable Vertical Ladders

If the vertical ladder is movable (e.g., can rotate because it is mounted on the side of a crane cab), the elevated height of the vertical guardrail shall continue horizontally to a distance of 600 mm (23.5 in.) from each side of the centerline of the movable object when it is at its travel limits.

5.3 Use of Vertical Ladder Safety Gates or Bars versus Safety Chains

Safety gates or bars, rather than safety chains, shall be used to protect personnel near the opening at the top of a vertical ladder.

Safety gates shall comply with the requirements of 4/4.8 “Safety Gates”:

6 Work Platforms

Work platforms shall be provided at locations where personnel must perform tasks that cannot be easily accomplished by reaching from an existing standing surface.

Work platforms exposed to the elements shall have additional slip resistance due to potential exposure to water and ice.

6.1 General Principles

The principles listed below apply to the design of work platforms.

i) Platforms shall be of sufficient size (see 4/6.2.2 FIGURE 19, "Work Platform Dimensions") to accommodate the task and allow for placement of any required tools, spare parts, or equipment.

ii) Work platforms more than 600 mm (23.5 in.) above the surrounding surface shall be provided with guard rails and hand rails as described in Section 4/2 "Walkways and Ramps" and Section 4/4, "Guard Rails and Hand Rails".

6.2 Design Loads

The design loads listed in the following Subparagraphs are design load requirements for the **ERGO** notations. Where requirements for design loads, specified by other regulatory bodies (e.g., flag Administrations and port State authorities), are greater than these design loads, those requirements take precedence over this Guide.

This Guide defines "design load" as the maximum intended load, being the total of all loads including the weight of the personnel, materials and equipment, including the means of access structure.

6.2.1 Guardrails

Guardrails shall withstand anticipated loads but not less than 90 kg (200 lbs) at any point and in any direction when applied to the top rail.

6.2.2 Design Loads and Maximum Deflection

The minimum design loads for the working platforms and landings are:

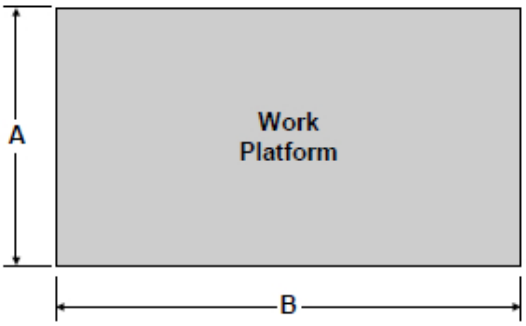
i) 2.0 kN/m^2 (0.29 lbf/in^2) under uniform load for the structure, and

ii) 1.5 kN (337 lbf) concentrated load applied in the most unfavorable position over a concentrated load area of 200 mm × 200 mm (8 in. × 8 in.) for the flooring.

iii) When loaded with the design load, the deflection of the flooring shall not exceed 1/200th of the span and the difference between the loaded and adjacent unloaded flooring shall not exceed 4 mm in height.

FIGURE 19
Work Platform Dimensions

Dimension		*Requirements*
A	Work platform width	≥ 750 mm (29.5 in.)
	Work platform width (if used for standing only)	≥ 380 mm (15.0 in.)
B	Work platform length	≥ 925 mm (37.0 in.)
	Work platform length (if used for standing only)	≥ 450 mm (18.0 in.)



7 Handles

This Subsection contains requirements related to the design of handles. The considerations listed below apply to the design and placement of handles and are not represented in the following figures.

7.1 General

i) Handles shall be designed to accommodate personnel wearing either lightweight and medium weight gloves or cold weather gloves and mittens. (See 4/7.2 FIGURE 20, “Handle Dimensions”).

ii) Handles shall be constructed of round bar.

iii) Handles are particularly useful where a vertical ladder comes up to a manhole from the deck below where the ladder does not extend through the platform (see 4/7.2 FIGURE 21, “Handle Placement (Ladder not Extending Through Platform)” or while passing through access hatches (see 4/7.2 FIGURE 22, “Handle Placement (Stepping Through a Vertical Hatch)”).

iv) Handles shall be accessible at all stages during climbing or traversing through access hatches (embarking and disembarking) and within reach of the shortest (e.g., 5th percentile female) user.

v) To provide for safe ascending and descending, while stepping onto or from ladders, individual ladder rungs or steps and through hatches or lightening holes, suitably located handles or handgrabs shall be provided. See 4/7.2 FIGURE 23, “Handle Placement (Stepping to or from a Vertical Ladder)”.

Handles exposed to the elements shall have additional slip resistance due to potential exposure to water and ice.

7.2 Handle Design/Placement

The following figures represent the different aspects of handle design, placement and dimensioning.

- 4/7.2 FIGURE 20, “Handle Dimensions”
- 4/7.2 FIGURE 21, “Handle Placement (Ladder not Extending Through Platform)”
- 4/7.2 FIGURE 22, “Handle Placement (Stepping Through a Vertical Hatch)”
- 4/7.2 FIGURE 23, “Handle Placement (Stepping to or from a Vertical Ladder)”

FIGURE 20
Handle Dimensions

Dimension		*Requirements*
A	Handle width	≥ 300 mm (12.0 in.) ≤ 350 mm (14.0 in.)
B	Handle height	100 mm (4.0 in.)
C	Radius (bend)	25 mm (1.0 in.)
D	Round bar diameter	25 mm (1.0 in.)

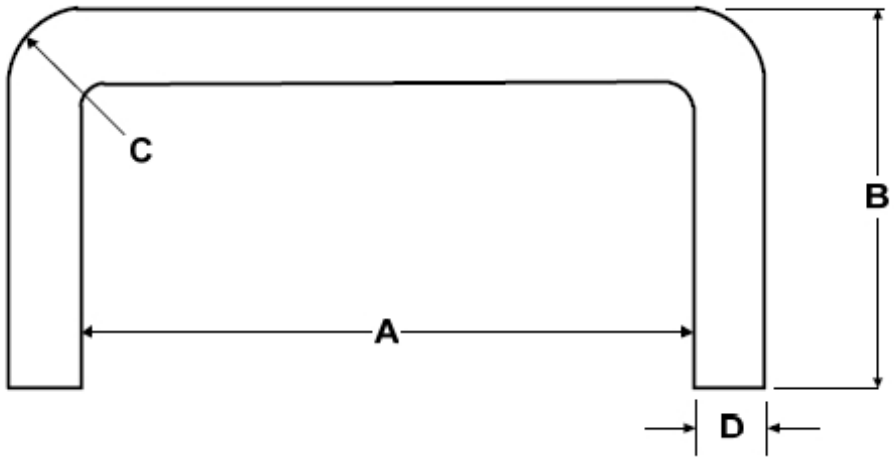


FIGURE 21
Handle Placement (Ladder not Extending through Platform)

Dimension		*Requirements**
Four Horizontal Handles		
A	Handle height above top of ladder and between handles	≥ 275 mm (11.0 in.) ≤ 300 mm (12.0 in.)
E	Round Bar Diameter	25 mm (1.0 in.)
Two Vertical Handles		
B	Height from top deck to handle	200 mm (8.0 in.)
C	Clearance between handles	400 mm (16.0 in.)
D	Height of handles	1000 mm (39.5 in.)
E	Round Bar Diameter	25 mm (1.0 in.)

* *Note:* Vertical ladder requirements apply (See 4/3.3, “Vertical Ladders”).

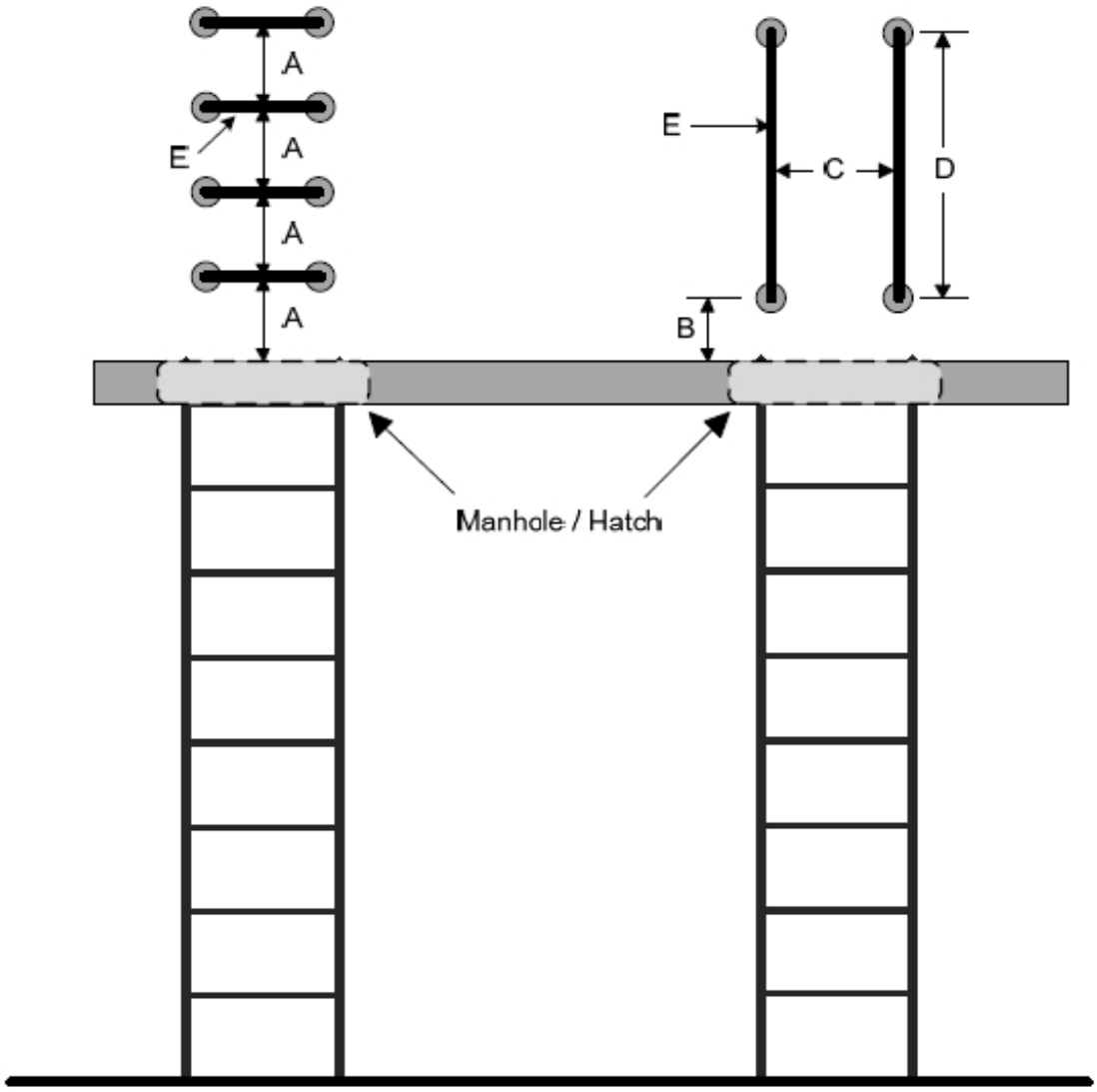


FIGURE 22
Handle Placement (Stepping Through a Vertical Hatch)*

Dimension		*Requirements*
A	Handle height (above top of opening)	100 mm (4.0 in.)
B	Distance between lower and upper edge of the hatch	≥ 1000 mm (39.5 in.)
C	Height required for a step	> 600 mm (23.5 in.)
D	Handle width (no upper limit in this case)	≥ 300 mm (12.0 in.)
E	Step height	One half of dimension C
F	Step width, hatch width	≥ 800 mm (31.5 in.) or ≥ Hatch width
G	Step depth (not shown in figure)	≥ 275 mm (11.0 in.) ≤ 300 mm (12.0 in.)

* *Note:* Handles and steps are provided on both sides of the hatch.

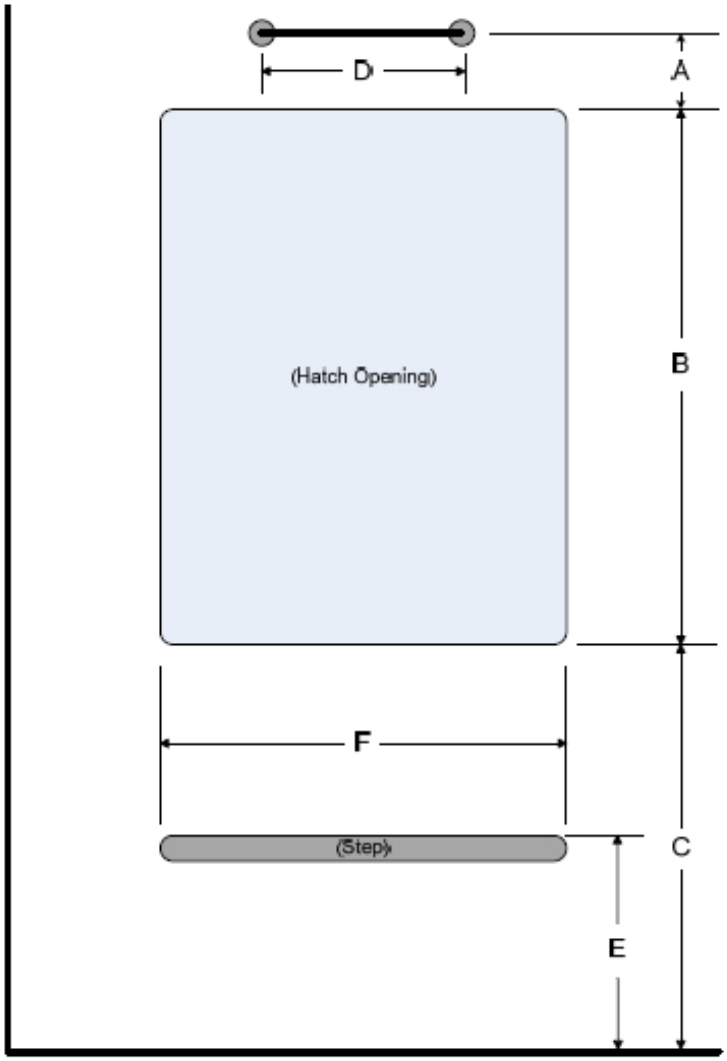


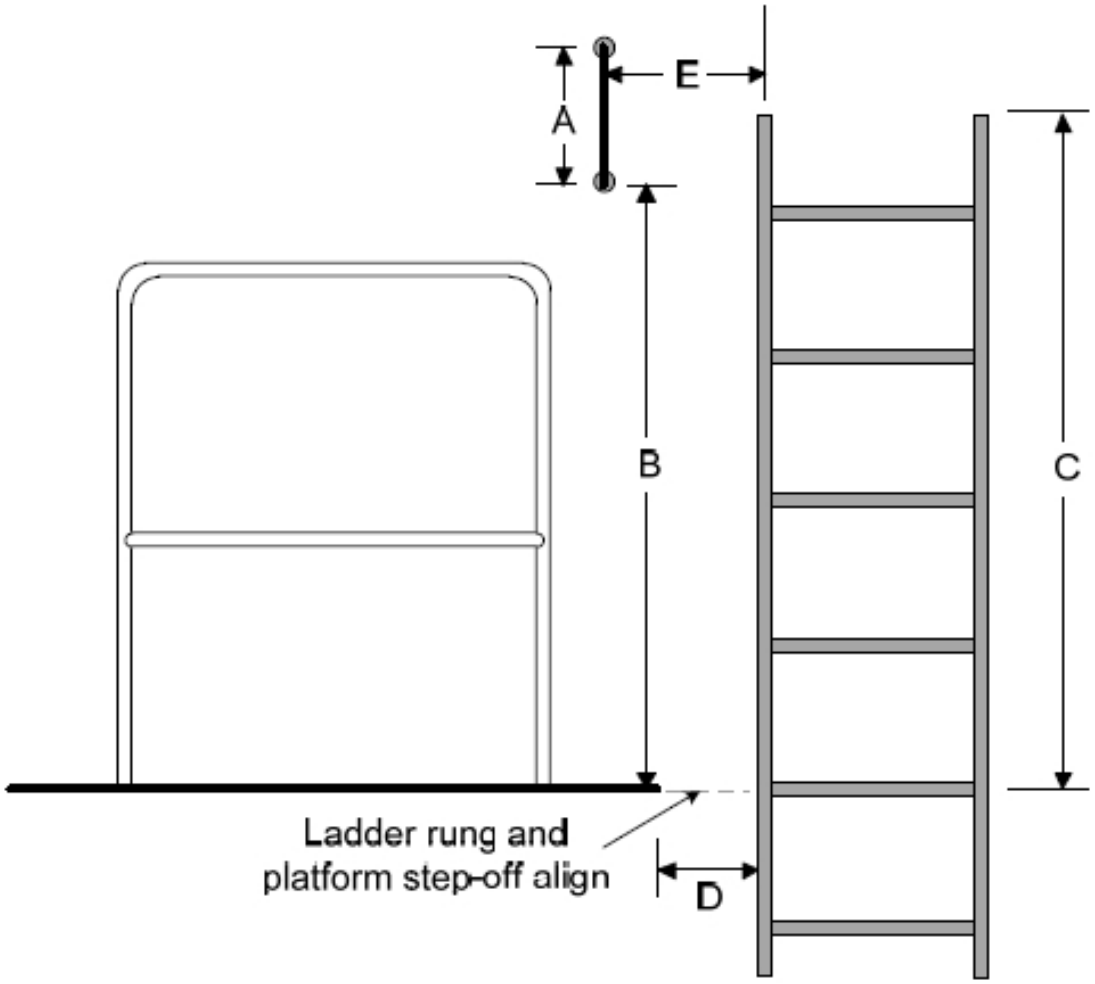
FIGURE 23
Handle Placement (Stepping to or from a Vertical Ladder)[1, 2]

Dimension		*Requirements*
A	Length of handle	≥ 300 mm (12.0 in.)
B	Handle starting height above landing or platform	≥ 1270 mm (50.0 in.)
C	Ladder stringer height above platform	≥ 1350 mm (53.25 in.)
D	Horizontal separation between vertical ladders and platform	≥ 150 mm (6.0 in.) ≤ 300 mm (12.0 in.)
E	Horizontal separation between vertical ladder and handle	≥ 225 mm (9.0 in.) ≤ 450 mm (18.0 in.)

Notes:

1 Vertical ladder requirements apply (See 4/3.3, “Vertical Ladders”).

2 Toeboard not shown.



8 Hatches

8.1 General

This Subsection contains requirements related to the design of hatches. The requirements included in the figures and tables below provide the design attributes for **ERGO** notations.

8.2 General Principles

The principles listed below apply to the design of hatches and lightening holes and are not represented in the following figures or tables.

i) For access through horizontal hatches, the dimensions shall be sufficient to allow a person wearing a self-contained air-breathing apparatus and protective equipment to ascend or descend any ladder without obstruction and also provide a clear opening to facilitate the movement of an injured person through the hatch.

Where hatch covers are heavy [e.g., above 11 kg (24.3 lbs)] or unwieldy, aids shall be provided to assist in lifting or lowering the hatch cover.

8.3 Hatch Design

4/8.3 FIGURE 24, "Hatch Design" and 4/8.3 FIGURE 25, "Hatch Design (Alternative Arrangement)" present requirements related to shapes and dimensions of hatches. 4/8.3 FIGURE 25 illustrates an IACS-approved alternative design for access. This design is subject to the verification of easy evacuation of injured or stretcher-borne personnel.

FIGURE 24
Hatch Design

Dimension		*Requirements*
A	Access – vertical height	≥ 1000 mm (39.50 in.)
B	Access – horizontal width	≥ 800 mm (31.50 in.)
C*	Height above deck or stepping tread	≤ 600 mm (23.5 in.)

* *Note:* If a vertical opening is at a height of more than 600 mm, steps and handgrips shall be provided.

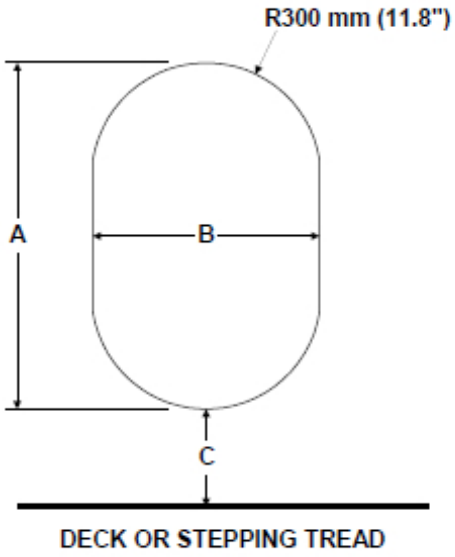
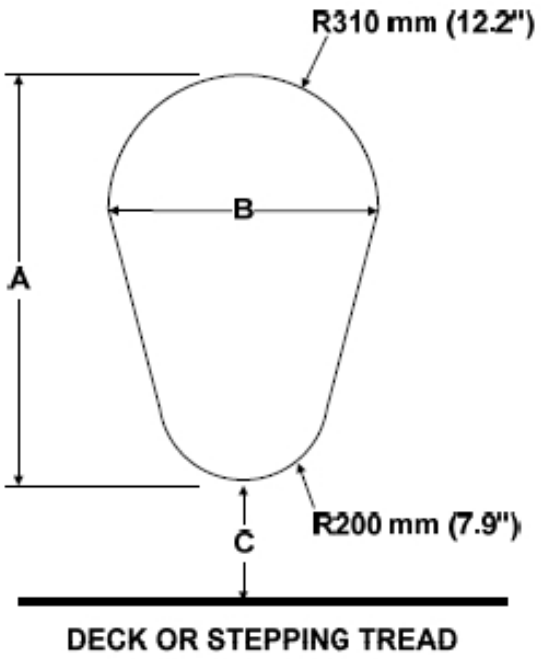


FIGURE 25
Hatch Design (Alternative Arrangement)

Dimension		*Requirements*
A	Access – vertical height	≥ 1000 mm (39.4 in.)
B	Access – horizontal width	≥ 800 mm (31.50 in.)
C*	Height above deck or stepping tread	≤ 600 mm (23.5 in.)

* *Note:* If a vertical opening is at a height of more than 600 mm, steps and handgrips shall be provided. For more guidance, see 4/7.2 FIGURE 22, "Handle Placement (Stepping Through a Vertical Hatch)".



8.4 Horizontal Hatch Access near a Coaming

When access to a cargo hold is arranged through the cargo hatch, the top of the ladder shall be placed as close as possible to the hatch coaming (see 4/8.4 FIGURE 26, "Ladder Distance from Hatch Coaming"). Access hatch coamings having a height greater than 900 mm (35.5 in.) shall also have steps on the outside in conjunction with the ladder (see 4/8.4 FIGURE 27, "Access Hatch Heights of ≥ 900 mm (35.5 in.)").

FIGURE 26
Ladder Distance from Hatch Coaming

Dimension		*Requirements*
A	Distance from ladder to hatch coaming	≥ 175 mm (7.0 in.) and ≤ 200 mm (8.0 in.)

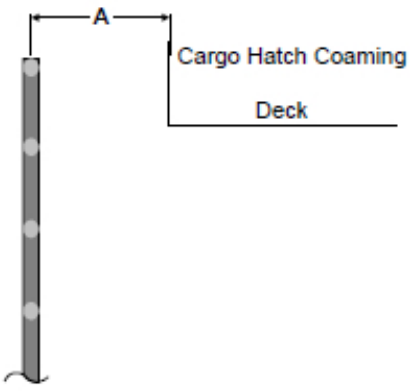
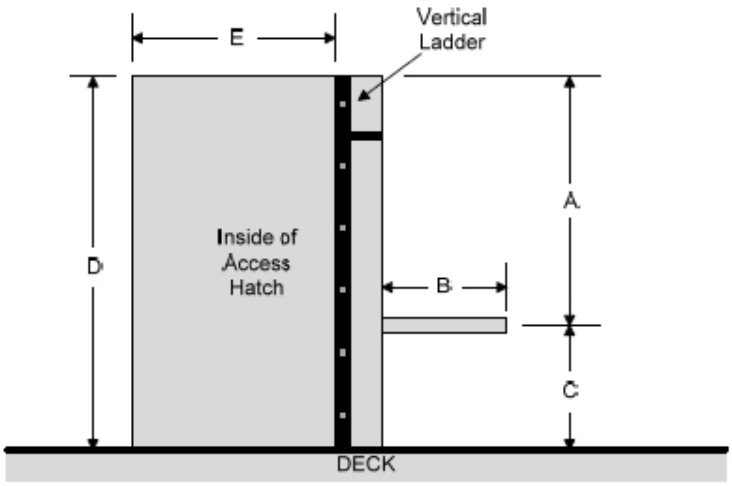


FIGURE 27
Access Hatch Heights of ≥ 900 mm (35.5 in.)

Dimension		*Requirements*
A	Distance from step to access hatch	600 mm (23.5 in.)
B	Step depth	≥ 275 mm (11.0 in.) ≤ 300 mm (12.0 in.)
C*	Step height	≤ 300 mm (12.0 in.)
D	Height to require steps along with the ladder	≥ 900 mm (35.5 in.)
E	Dimension inside of hatch without obstruction	≥ 750 mm (29.5 in.)

* *Note:* The limiting height is dimension 'A'. This height is set by the crotch height of the 5th percentile female. Once 'D' exceeds 900 mm (35.5 in.), a step is needed. Therefore, 'C' could be anything from 25 mm (1 in.) up to 300 mm (12 in.).

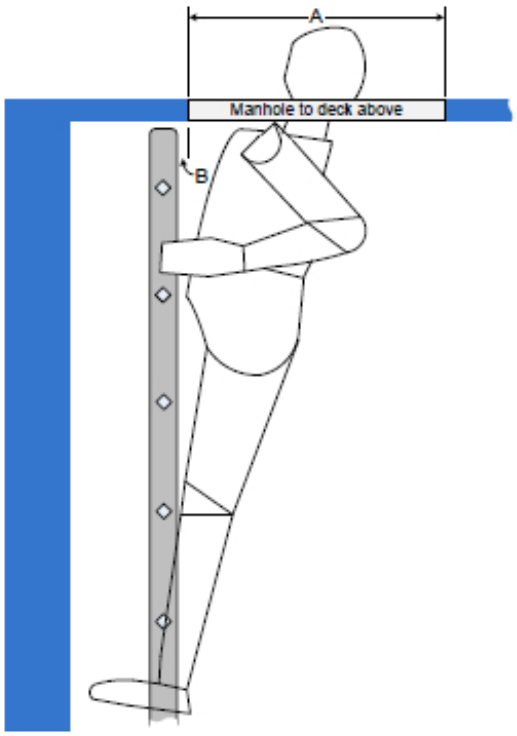


8.5 Horizontal Hatch Access through a Deck

For access to the deck from a ladder below, the top of the ladder shall be placed within 50 mm (2 in.) of the leading edge of the hatch opening (see 4/8.5 FIGURE 28, "Horizontal Hatch Access through a Deck"). Minimum dimension of the opening (round or square) is 810 mm (32 in.).

FIGURE 28
Horizontal Hatch Access through a Deck

Dimension		*Requirements*
A	Dimension of Opening (Circular or rectangular)	≥ 810 mm (32 in.)
B	Ladder to edge of opening separation	≤ 50 mm (2 in.)



9 Doors and Scuttles

9.1 General

This Subsection contains requirements related to the design of door and scuttles. The requirements presented below provide the design attribute (application) for **ERGO** notations.

9.2 Means of Escape or Egress

9.2.1 Door Operation

Doors, hatches, or scuttles used as a means of escape shall be capable of being operated by one person, from either side, in both light and dark conditions. Doors shall be designed to prevent opening and closing due to vessel motion and shall be operable with one hand.

9.2.2 Door Dimensions

Doors (other than emergency egress) used solely by crew members shall have a clear opening width of at least 710 mm (28 in.) The distance from the deck to the top of the door shall be at least 1980 mm (78 in.).

9.2.3 Clear Means of Escape

The method of opening a means of escape shall not require the use of keys or tools. Doors in accommodation spaces (with the exception of staterooms), stairways, stair towers, passageways, or control spaces, shall open in the direction of escape or egress.

9.2.4 Markings

The means of escape shall be marked from both the inside and outside.

9.3 Deck Scuttles

Deck scuttles that serve as a means of escape shall be fitted with a release mechanism that does not require use of a key or a tool, and shall have a holdback device to hold the scuttle in an open position.

Deck scuttles that serve as a means of escape shall have the following dimensions:

i) Round – 670 mm (26.5 in.) or greater in diameter

ii) Rectangular – 670 mm (26.5 in.) by 330 mm (13 in.) or greater

10 Manual Valve Operation, Access, Location, and Orientation

10.1 General

The requirements in this Subsection apply to the manual operation of valves, including those operated by handwheels, levers, or extenders, or operated locally or remotely with motor operators while deployed at sea.

10.2 Categorization of Valves for Selection of Location

10.2.1 Applicability

Valve location, accessibility, orientation, and ease of use shall be determined on the basis of valve criticality to determine valve location and access based on criticality and method and frequency of use. The following three categories define valve criticality.

10.2.2 Category 1 Valves

Category 1 valves include those essential to normal or emergency operations where rapid and unencumbered access and operation or maintenance is essential. Thus, permanent access shall be provided at a deck level or via a permanent standing surface. If such access is not practical, access by stair or ladder is acceptable. Valves meeting any of the following will be qualified as Category 1 valves:

i) Valves that are essential for operations

ii) Overboard valves

iii) Equipment isolation valves

iv) Valves that are essential for personnel or process safety, cargo protection, and pollution prevention

v) Valves where there is a high likelihood of failure

vi) Valves where the consequence of failure or lack of quick access would result in damage to personnel or property, loss of productivity, or damage to equipment or the environment

vii) Valves where an expected operational and/or maintenance frequency is greater than once in a six month period

Examples of valves typically included in Category 1 are:

i) Control valves, their bypasses and isolation valves

ii) Relief valves and depressuring valves

iii) Trip and anti-surge control valves

iv) Ballast water discharge valves

10.2.3 Category 2 Valves

Category 2 valves are those that are not critical for normal or emergency operation or maintenance but are used during routine maintenance activities.

These shall be located with permanent access at deck level, access via stair, or other access aid with a purpose-built standing surface/landing.

Examples of valves typically in Category 2 are:

i) Sewage treatment valves

ii) Drain valves

iii) Service oil valves

iv) Battery limit valves

v) Gas-freeing connections

vi) Manual valves with an expected operating and/or maintenance frequency of less than once per six months

vii) Valves where quick action is not required

10.2.4 Category 3 Valves

Category 3 valves are those used in particular circumstances on an infrequent or rare basis. While no specific location requirements are imposed for Category 3 valves, several requirements exist related to safety of Category 3 valve use and operation.

Examples of valves typically included in Category 3 are:

i) Valves used in drydock only

ii) Valves used in initial commissioning

iii) Valves used for decommissioning

iv) Valves used to isolate pressure vessels, tanks, etc., for inspections

v) Valves for pressure test

10.2.5 Assignment of Guide Requirements by Valve Category

For Category 1 valves, unless otherwise indicated, all the requirements stated in this section apply to Category 1 valves.

Category 2 valve requirements are indicated in the requirements statements. Any requirement that applies to Category 2 valves also applies to Category 1 valves.

Category 3 valves have no specific access, positioning, or orientation requirements. However, safety of use and operation requirements are imposed on Category 3 valves.

10.3 Principles

10.3.1 General Access

For valves required by function or design to be readily accessible, the valve, or its control, shall be:

i) Located according to its criticality, with more critical valves being more readily accessible than less critical valves (Category 1 and 2)

ii) Located in a space normally entered without using tools or requiring keys (Category 1 and 2)

iii) Clear of, and protected from, obstructions, moving equipment, and hot surfaces that may prevent or delay operation or maintenance (Category 1 and 2)

Within arm's reach without requiring use of extenders, portable ladders, or other portable access aids. (See 4/10.4, "Valve Mounting Heights and Orientation")(Category 1, 2, and 3).

Valves shall be located so the operator or maintainer does not have to stand on nearby pipes, cable trays, handrails, equipment, or any object not meant specifically to be used as a working surface for the operation, maintenance, repair, or replacement of any valve (Category 1, 2, and 3).

Valves shall not be mounted in positions where stems on handwheels or levers will extend into normal walking or climbing areas (Category 1, 2, and 3).

Valves exposed to the elements shall be provided means of deicing (Category 1 and 2).

All valve handles, handwheels, levers or other grasp areas shall be located to provide at least 75 mm (3 in.) of clearance from obstructions during valve operation for all points of travel of the valve actuator (Category 1, 2, and 3).

10.3.2 Emergency Access

Valves used for emergency operations shall not be located below deck gratings or behind covers. (Category 1 and 2)

If it is absolutely necessary to locate valves behind covers (e.g., to meet a regulatory requirement), the cover shall be capable of being opened without requiring any tools or the removal of any securing fasteners. The cover shall be labeled to identify the valve. (Category 1 and 2)

10.3.3 Valve Operators and Indicators

Valves shall close with a right hand (clockwise) motion of the handwheel or lever when facing the end of the stem, or where left-handed valves are provided, direction or turn to close the valve shall be indicated on the valve, its label, or on the handwheel itself. (Category 1 and 2)

Valve position indicators shall be installed on each valve. (Valves where the position of the stem (i.e. rising stem valves) or the position of the handle (i.e., ball valve) provides a direct indicator of the valve position do not require an additional "valve position indicator"). (Category 1, 2, and 3)

Valve position indicators shall be directly visible to the operator or maintainer from the normal body position required to open or close the valve. (Category 1 and 2)

Valves shall be capable of being operated without mechanical extenders such as a reach rod or chain operators. (Category 1)

For valves fitted for remote control (mechanically operated from another location):

i) An independent indicator showing the position of the valve (open, closed, or midway) shall be provided at the control. (Category 1 and 2)

ii) An independent indicator showing the position of the valve (open, closed, or midway) shall be provided at the physical location of the valve. (Category 1 and 2)

iii) Category 1 valves shall be provided redundant controls located near or on the valve body itself (for the cases where remote means of operation is not working).

10.3.4 Labeling, Marking, and Coding

i) Labels shall be provided to identify manual valves. (Category 1 and 2)

ii) Labels, markings and coding shall be visible to the operator from the normal body position required to open or close the valve. (Category 1 and 2)

10.3.5 Clearances

i) Clearance of at least 300 (12 in.) for wrenches shall be provided adjacent to flanged connections for valves and equipment where bolts can be accessed from one side only. (Category 1 and 2)

ii) Clearance of at least 760 mm (30 in.) shall be maintained on both sides of pipe where access for working must be provided, or where accessing bolts from both sides of a pipe with a diameter greater than 300 mm (12 in.) pipe. (Category 1 and 2)

iii) A 75 mm (3 in.) clearance shall be maintained all around valve handwheels, except that 40 mm (1.5 in.) and smaller valves where operation is by hand or wrist motion may have less clearance, minimum 40 mm (1.5 in.) finger clearance. (Category 1 and 2)

10.3.6 Maximum Force

The maximum force to initially crack open a manual valve shall not exceed 450 N (100 pound force).(Category 1 and 2)

10.3.7 Turning Aids

Knurling, indentation, high-friction covering, or a combination of these shall be built into handwheels to facilitate the operator's grasp for applying maximum force. (Category 1 and 2)

10.3.8 Handwheel Rim Dimension

i) The handwheel rim for handwheels with diameter larger than 150 mm (6 in.) shall be cylindrical to facilitate grasping and applying maximum force. (Category 1 and 2)

ii) The rim diameter shall be 20 to 40 mm (0.75 to 1.5 in.). (Category 1 and 2)

10.3.9 Human Endurance

i) The human endurance limit applied shall be 100 turns maximum to open or close a valve at a rate between 15 and 60 revolutions per minute. (Category 1 and 2)

ii) Where the above requirement (item *i)*) is not met, a hand-held power (pneumatic, hydraulic, or electric) valve-turning machine shall be provided. (Category 1 and 2)

iii) The weight of such a hand-held valve-turning machine shall not be in excess of 20 kg. (44 lbs).(Category 1 and 2)

10.4 Valve Mounting Heights and Orientations

10.4.1 Handwheel-Operated Valves

Handwheels of less than 100 mm (4 in.) in diameter shall be provided when intended for one-hand operation. Handwheels of greater than 150 mm (6 in.) diameter shall be provided when intended for two-hand operation. (Category 1 and 2)

Handwheels with diameters between 100 mm (4 in.) and 150 mm (6 in.) shall be avoided (since they are too large for one-hand operation and too small for two-hand operation). (Category 1 and 2)

Valve handwheels shall be located as shown in the following figures for orientation of valve stem in the vertical, horizontal, or angled position.

- Figure 29, "Mounting Heights for Handwheel Valves with Vertical Stems"
- Figure 30, "Mounting Heights for Handwheel Valves with Horizontal Stems"
- Figure 31, "Mounting Heights for Handwheel Valves with Angled Stems"

Per Section 4, Figures 29, 30, and 31, Category 1 valves can be located in either Category 1 or 2 valve locations when:

i) Handwheels are in excess of 600 mm (23.5 in.) diameter, or

ii) Valves are used for emergency responses, (for example, fire fighting or de-ballasting), or

iii) Valves where stem freeze-up is possible, or

iv) Handwheel operating torque is in excess of 54 N-m (40 ft-lbs), or

v) The valve may be expected to be operated by a short male or female.

Per the figures, Category 2 valve locations are reserved for Category 2 valves, and Category 1 valves shall not be fitted in those locations.

Category 1 or 2 valves shall not be fitted outside the indicated locations.

FIGURE 29
Mounting Heights for Handwheel Valves with Vertical Stems

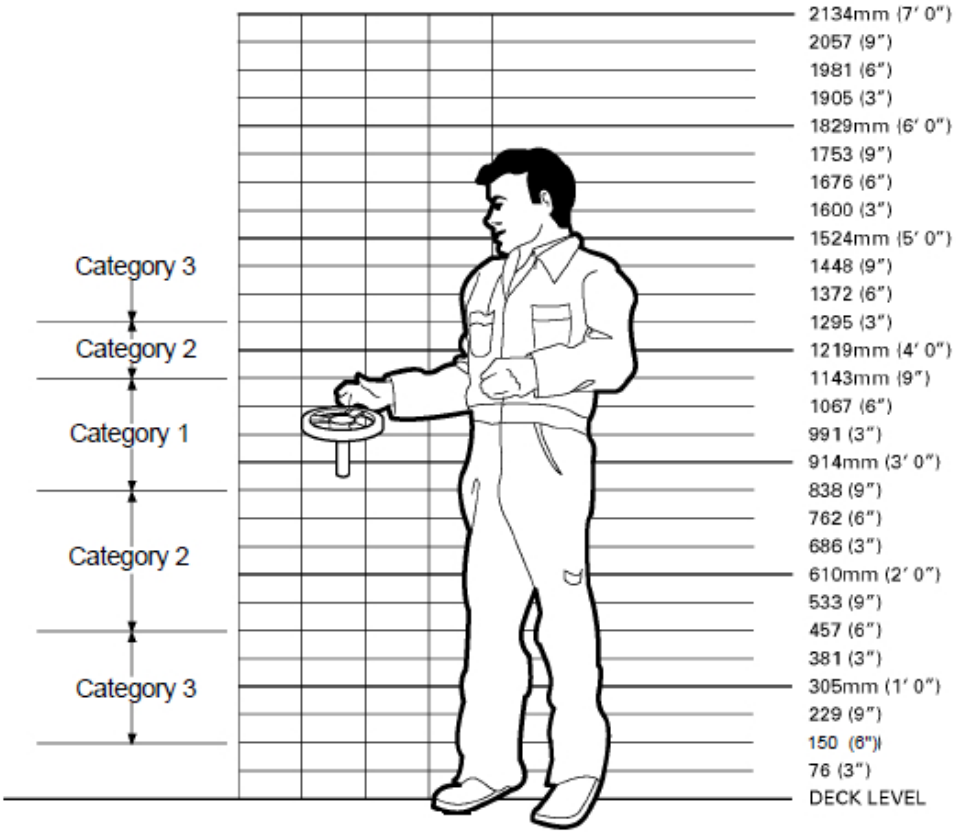


FIGURE 30
Mounting Heights for Handwheel Valves with Horizontal Stems

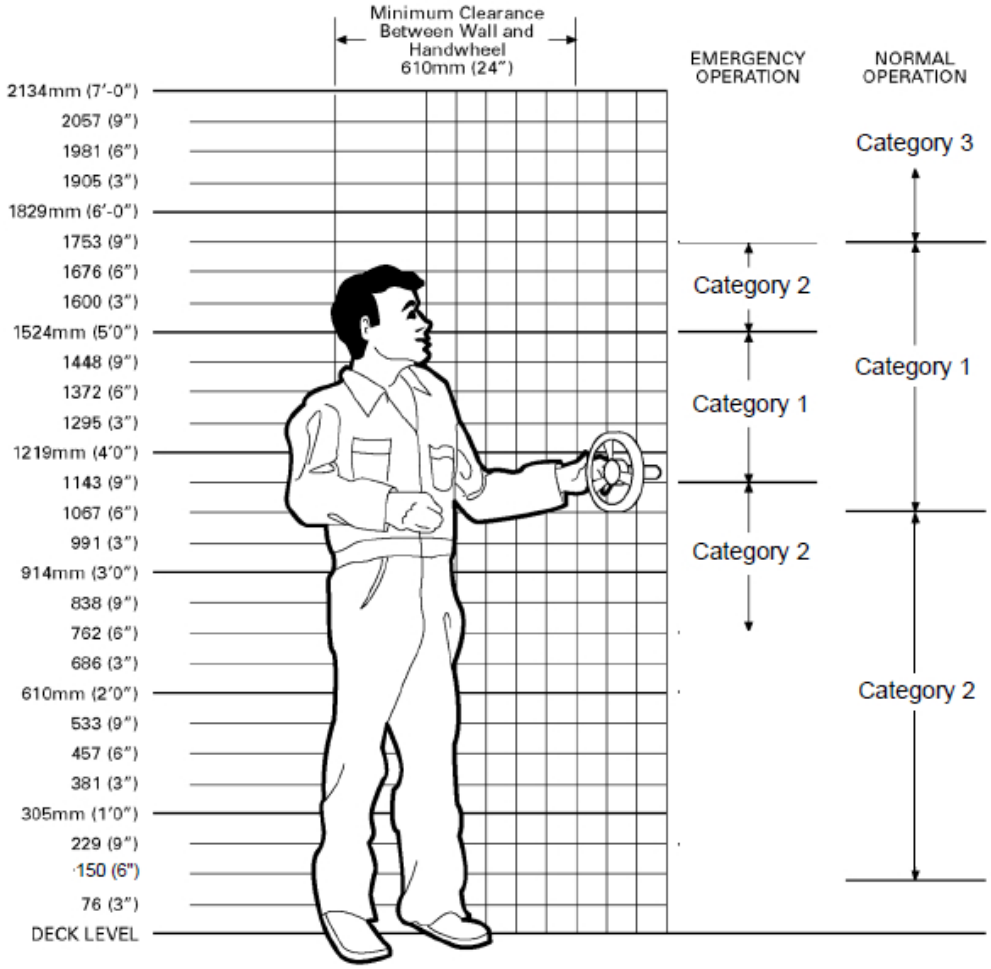
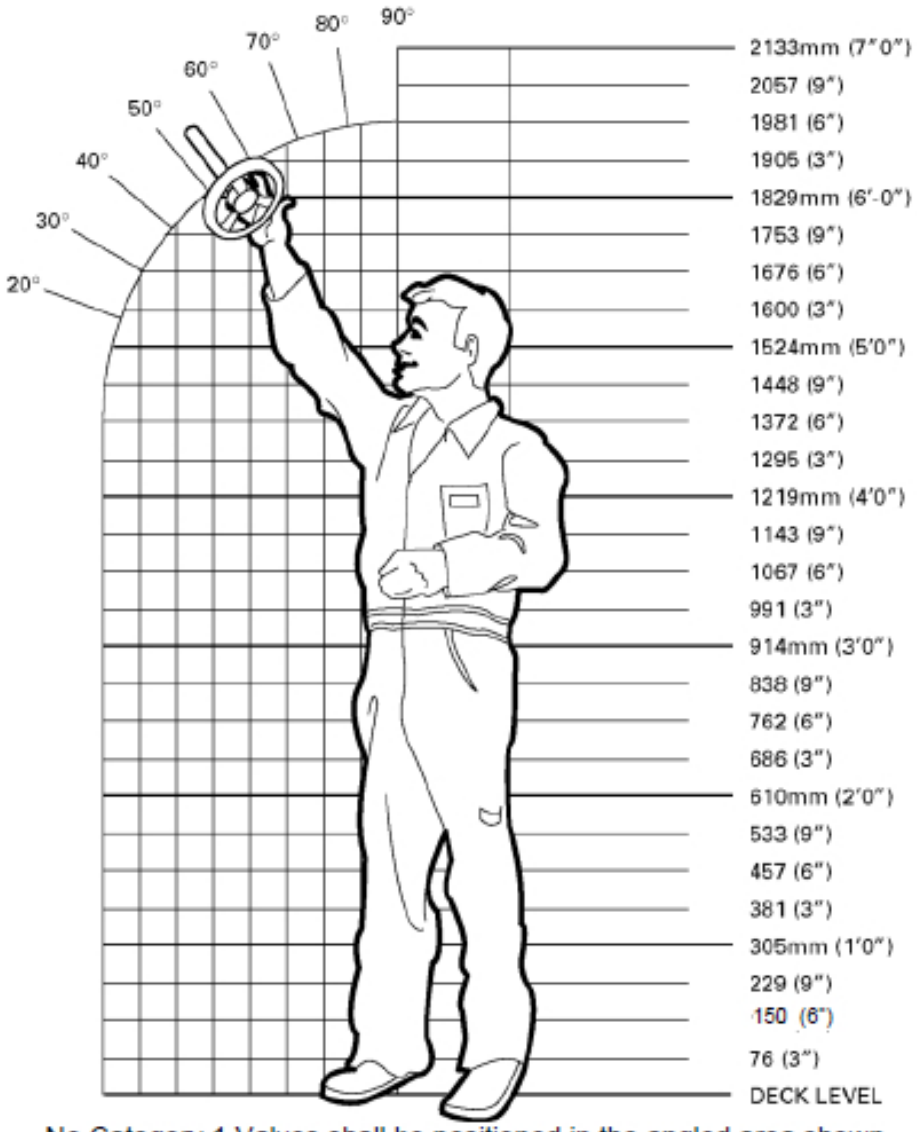


FIGURE 31
Mounting Heights for Handwheel Valves with Angled Stems



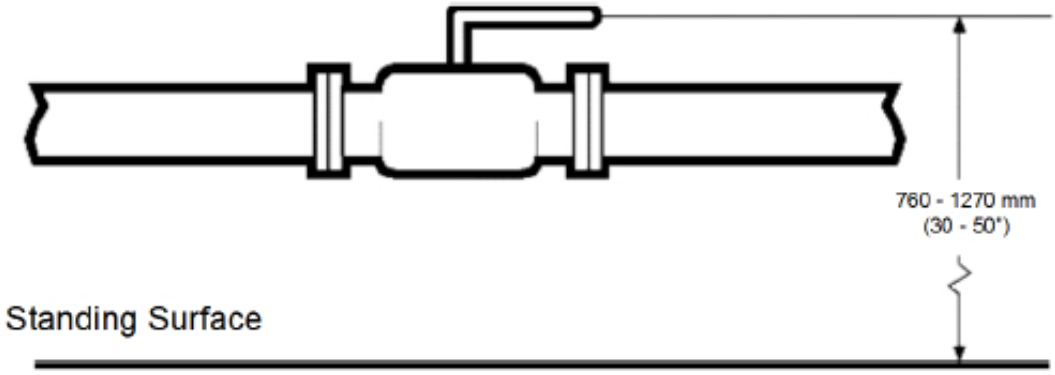
No Category 1 Valves shall be positioned in the angled area shown (20° to 90°)".

No Category 2 valves shall be positioned above 40 degrees.

10.4.2 Lever-Operated Valves

Lever-operated valves oriented with the stem in a vertical position shall be provided when the valve lever can be located between 760 mm (30 in.) and 1270 mm (50 in.) above the standing surface, as shown in 4/10.4.2 FIGURE 32, "Mounting Heights for Lever-Operated Valves with Vertical Stems". (Category 1 and 2)

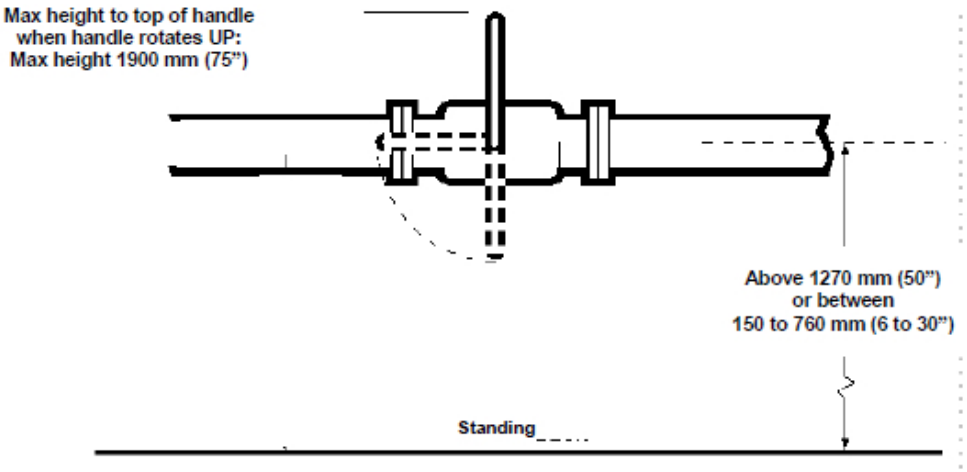
FIGURE 32
Mounting Heights for Lever-Operated Valves with Vertical Stems



Lever-operated valves oriented with the stem in a horizontal position shall be provided when the lever is located between 150 mm (6 in.) and 760 mm (30 in.), or more than 1270 mm (50 in.) above the standing surface, as shown in 4/10.4.2 FIGURE 33, "Mounting Heights for Lever-Operated Valves with Horizontal Stems". The maximum height above the standing surface to the lever tip shall not exceed 1900 mm (75 in.). (Category 1 and 2)

Horizontal stem valves shall not be located overhead in working areas. (Category 1 and 2)

FIGURE 33
Mounting Heights for Lever-Operated Valves with Horizontal Stems



10.5 Alternative Valve Orientations

10.5.1 Valves in the Overhead Position

When it is necessary to locate a manual valve's actuator above a user's head, the operating torque shall be no more than 27 N-m (20 ft-lbs). (Category 1 and 2)

Valve handwheels shall not be larger than 510 mm (20 in.) in diameter. (Category 1 and 2)

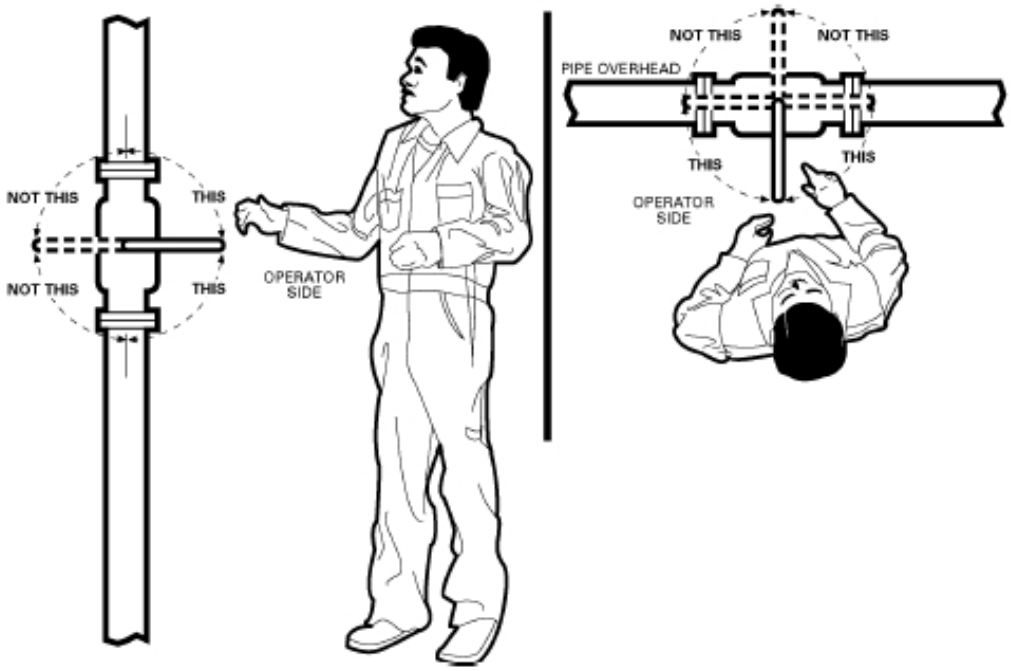
10.5.2 Valves in Walkways

Valve orientation shall not place the valve lever into a passageway. (Category 1, 2 and 3)

10.5.3 Valves Accessible from One Side Only

When access to a lever-operated valve is available from one side only, the valve shall be mounted such that the lever moves to and from the accessible side where the operator or maintainer will be positioned as shown in 4/10.5.3 FIGURE 34, "Direction of Travel for Valve Levers Accessible from One Side Only". (Category 1 and 2)

FIGURE 34
Direction of Travel for Valve Levers Accessible from One Side Only



10.5.4 Valves at or Below Standing Surfaces

If a valve is located at or below the standing surface, requiring stooping or squatting to operate the valve, the valve position in relation to an operator's or maintainer's body position shall be as shown in 4/10.5.4 FIGURE 35, "Physical Reach from a Stooping or Squatting Position". (Category 3 only)

When it is necessary to locate handwheel or lever valves below the operator's or maintainer's standing surface, horizontal- or vertical-oriented valves shall be installed as shown in 4/10.5.4 FIGURE 36, "Mounting Position For Valve Levers and Handwheels Below Standing Surface". (Category 3 only)

Deck opening sizes to reach and operate levers or handwheels located below the standing surface and oriented parallel to the standing surface shall be as shown in 4/10.5.4 TABLE 5, "Access Opening and Mounting Depth Dimensions for Levers and Handwheels Oriented Parallel to the Standing Surface". This table also includes guidance on mounting depths for valves. (Category 3 only)

FIGURE 35
Physical Reach from a Stooping or Squatting Position

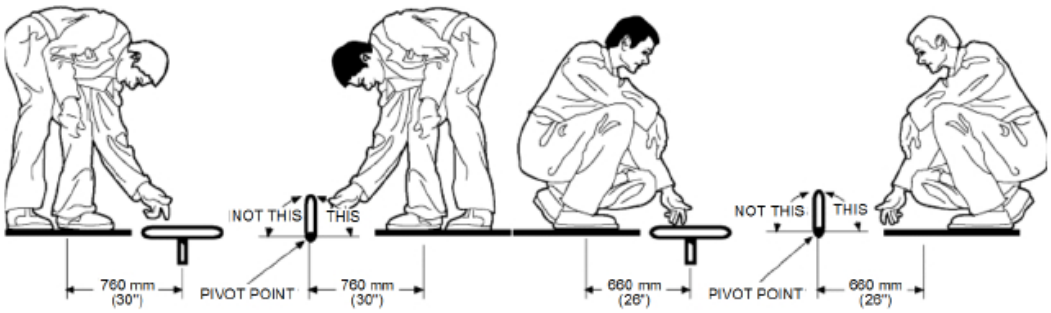


FIGURE 36
Mounting Position for Valve Levers and Handwheels Below Standing Surface

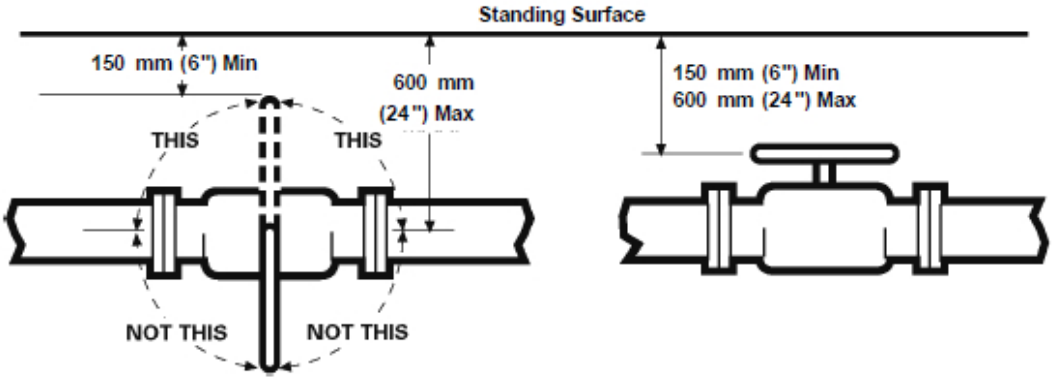


TABLE 5
Access Opening and Mounting Depth Dimensions for Levers and Handwheels Oriented Parallel to the Standing Surface

Valve Handle(Diameter or Length)	*Depth Below Deck*	*Deck Opening Size(square or diameter)*
Handwheel		
130 mm (5 in.) or less	150 - 255 mm (6 - 10 in.)	180 mm (7 in.)
	Greater than 255 mm (10 in.)	215 mm (8.5 in.)
130 mm (5 in.) or more	150 mm (6 in.) to 510 mm (20 in.)	The diameter of the handwheel plus 150 mm (6 in.) with a minimum of 360 mm (14 in.)

Lever		
Any Lever Length	Any Depth	Lever Length greater than 50 mm (2 in.)

10.5.5 Valves Operated from a Ladder

Where valves must be operated from a permanent ladder, they shall be limited to those that can be operated with one hand (valves with handwheels less than 155 mm (6 in.) in diameter and lever valves.). (Category 1 and 2)

Valve levers shall not intrude into the ladder climbing place. (Category 1, 2, and 3)

The ladder shall be positioned to allow operation of a valve within a 610 mm (24 in.) distance forward of the ladder or 1220 mm (48 in.) distance from the side of the ladder as shown in 4/10.5.6 FIGURE 37, "Orientation and Reach for Ladder Parallel to Valve Levers" and 4/10.5.6 FIGURE 38, "Orientation and Reach for Ladder Perpendicular to Valve Levers". (Category 1 and 2)

These figures show the required ladder orientation in relation to valves. The valve orientation, direction of valve operation, and distances shown are applicable to both lever and handwheel-operated valves. 4/10.5.6 FIGURE 39, "Operating Lever Valves from a Ladder" gives additional guidance for placement of valves in relation to ladders. (Category 1 and 2)

10.5.6 Valve Handwheel Accessibility from Elevated Platforms

Valve handwheels operated from elevated platforms 1830 mm (72 in.) or more above grade shall be located within the confines of the platform railing. (Category 1 and 2)

FIGURE 37
Orientation and Reach for Ladder Parallel to Valve Levers

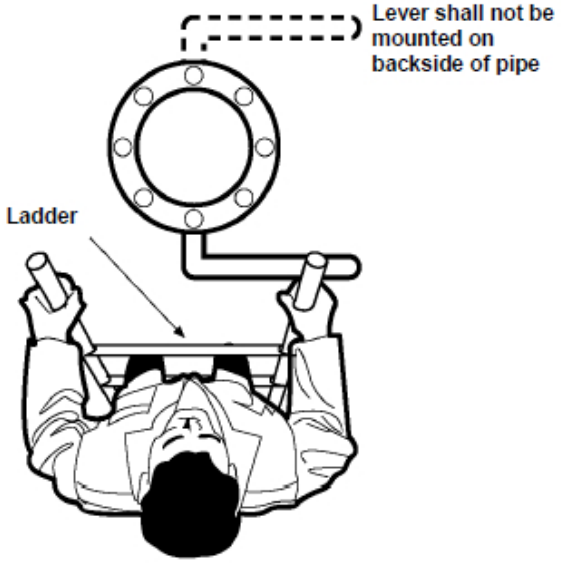


FIGURE 38
Orientation and Reach for Ladder Perpendicular to Valve Levers

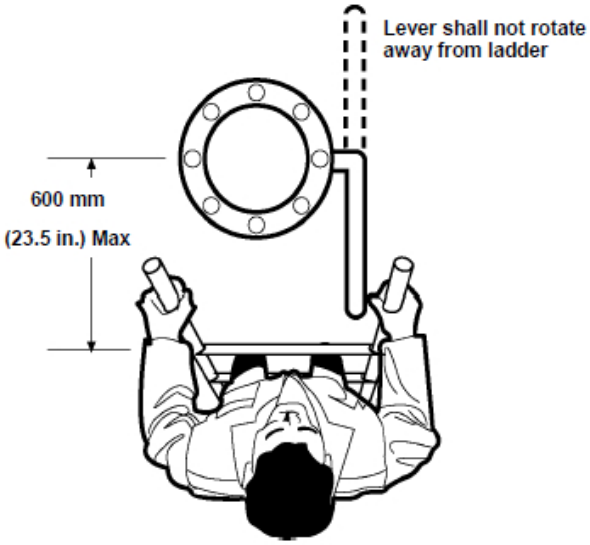
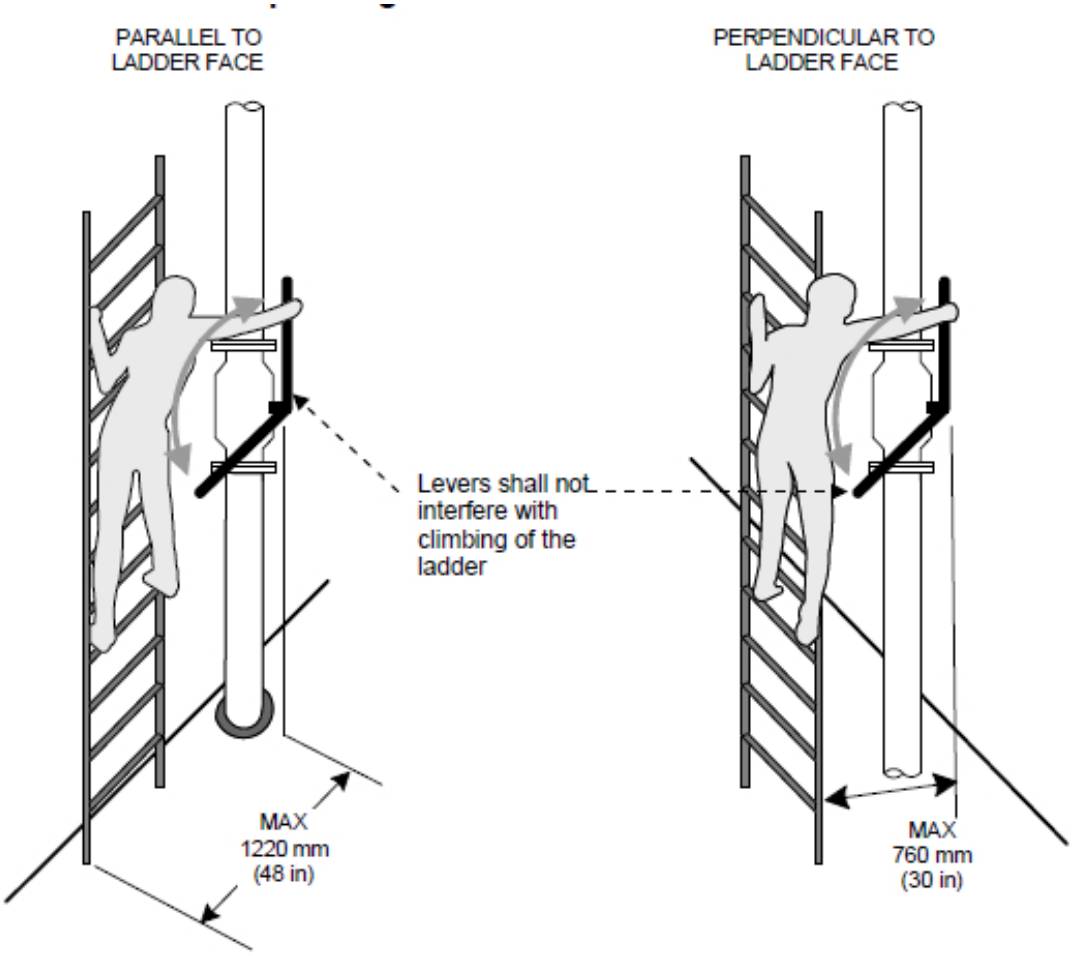


FIGURE 39
Operating Lever Valves from a Ladder



11 Maintenance or Operational Access

11.1 Maintenance or Operational Access Criticality Analysis

11.1.1 Applicability

Equipment location and accessibility shall be determined on the basis of a maintenance criticality analysis based on the criticality, frequency, and inherent safety of inspection, planned maintenance, or repair (see Appendix A2, “Maintenance Task Access Analysis”,for guidance). The assessments of safety or system criticality can be achieved by conduct of risk analyses, failure modes analyses, or other commonly accepted and applied techniques. Identification of criticality is used to determine the specific applicability of the requirements in this section to specific access locations. Identification of individual access criticality can be of joint participation among vessel designers, operators, and owners. The following three categories define maintenance criticality.

11.1.2 Category 1 Maintenance or Operational Access

Category 1 maintenance or operational criticality shall include those maintenance actions that are system and safety critical, meaning a system necessary for the safe operation of the vessel cannot

function without that aspect being functional. All of the requirements in this section apply to Category 1 maintenance items.

11.1.3 Category 2 Maintenance or Operational Access

Category 2 maintenance or operational criticality shall include those maintenance actions which are important to maintain operations, or any maintenance actions that are performed frequently. The requirements in this section that apply to Category 2 maintenance or operational items are identified as part of each requirement statement.

11.1.4 Category 3 Maintenance or Operational Access

Category 3 maintenance or operational criticality shall include those maintenance actions which are considered to be non-critical to system status and safety, and that do not require frequent access. There are no requirements in this section that apply to access to Category 3 maintenance or operational items.

11.2 Principles

11.2.1 General Access

Structural components (e.g., stiffeners, stairs, pedestals, etc.) shall not prevent access to, or removal of, maintained equipment. (Category 1 and 2)

Maintenance items that need to remain accessible shall not be blocked by removal of panel cases and covers. (Category 1 and 2)

Maintenance items that are exposed to the external environment shall be provided with means of deicing. (Category 1 and 2)

11.2.2 Equipment Design

Design shall include identification (such as labels), orientation, and alignment of components and subassemblies (including cables and connectors). (Category 1 and 2)

Skids (generators, air compressors, etc.) shall provide direct means of access to doors and removable panels to provide access to internal components for maintenance. (Category 1 and 2)

11.3 Access Design

11.3.1 General

i) Equipment shall allow for access to carry out maintenance without the removal of other parts or components, and clearance shall be provided to effectively use tools through their full range of motion. (Category 1 and 2)

ii) Permanent access aids including ladders, stairs, platforms, and ramps shall be provided for all Category 1 and 2 maintenance items. (Category 1 and 2)

iii) Every ladder should have a padeye for chain fall attachment so repair parts and tools can be hauled up if the overhead crane is not available or is not accessible. (Category 1 and 2)

iv) Equipment design shall permit maintenance from above, in front, from behind and outside with visibility, rather than from underneath or inside components or without complete visibility. (Category 1 and 2)

v) A minimum of 2.0 m^2(18 ft^2) per person minimum shall be provided for personnel, their clothing (including required PPE), tools, and equipment, as well as free space for the movements and activities required to perform maintenance tasks. (Category 1 and 2)

vi) When maintenance requires the removal of large internal or external parts (e.g., tube bundles from a heat exchanger, cylinder heads), a lay down area shall be provided for the component, parts, tools, and equipment. (Category 1 only)

vii) Lateral clearance for hand access between a bulkhead and nearby structures (for example, a skid) shall not be less than 425 mm (17 in.). (Category 1 and 2)

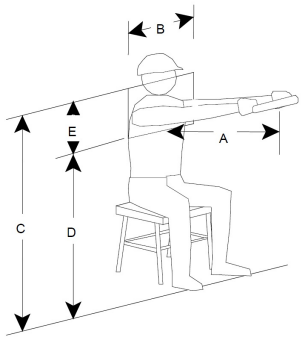
11.3.2 Physical Access

When maintenance tasks require the maintainer to squat, kneel, sit down, or stand sideways, access design shall accommodate these postures according to the following tables and associated figures (Category 1 and 2 applies to Section 4, Tables 6 through 11):

- 4/11.3.2 TABLE 6, "Seated, Forward Reach – Both Arms"
- 4/11.3.2 TABLE 7, "Cross-Legged Seated, Forward Reach – Both Arms"
- 4/11.3.2 TABLE 8, "Standing, Forward Reach – Both Arms"
- 4/11.3.2 TABLE 9, "Standing, Single Arm Forward Reach"
- 4/11.3.2 TABLE 10, "Standing, Single Arm Lateral Reach"
- 4/11.3.2 TABLE 11, "Squatting, Kneeling Space Dimensions"

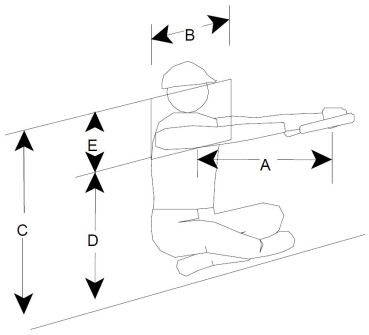
The dimensions in these tables apply to vessel structure access and vendor-supplied equipment and systems (skids).

TABLE 6
Seated,Forward Reach – Both Arms



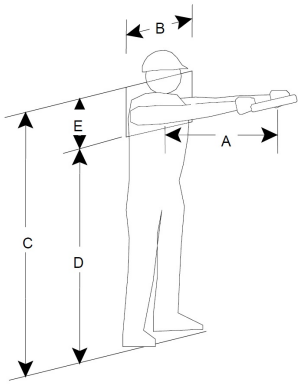
	Dimensions
A. Depth of reach	500 mm (19 in.) maximum
B. Breadth of aperture	425 mm (17 in.) minimum
C. Floor to top of aperture	1125 mm (44 in.) minimum
D. Floor to bottom of aperture	950 mm (37 in.) minimum
E. Vertical dimension of aperture	300 mm (12 in.) minimum

TABLE 7
Cross-Legged Seated,
Forward Reach – Both Arms



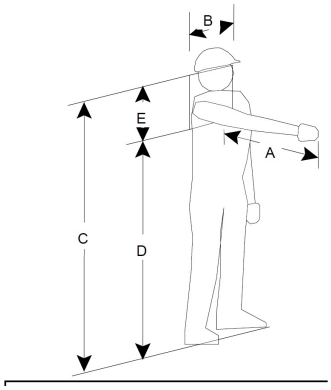
aaa	*Dimensions*
A. Depth of reach	450 mm (18 in.) maximum
B. Breadth of aperture	425 mm (17 in.) minimum
C. Floor to top of aperture	675 mm (26 in.) minimum
D. Floor to bottom of aperture	500 mm (20 in.) minimum
E. Vertical dimension of aperture	275 mm (11 in.) minimum

TABLE 8
Standing,
Forward Reach – Both Arms



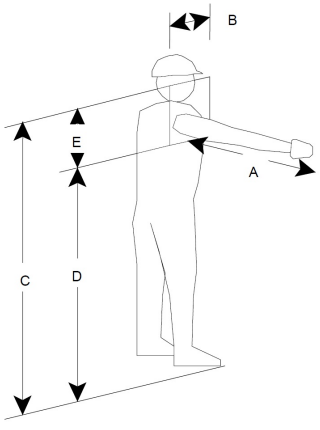
	Dimensions
A. Depth of reach	575 mm (23 in.) maximum
B. Breadth of aperture	475 mm (18 in.) minimum
C. Floor to top of aperture	1700 mm (66 in.) minimum
D. Floor to bottom of aperture	1450 mm (57 in.) minimum
E. Vertical dimension of aperture	425 mm (17 in.) minimum

TABLE 9
Standing,
Single Arm Forward Reach



	Dimensions
A. Depth of reach	650 mm (25 in.) maximum
B. Breadth of aperture	300 mm (12 in.) minimum
C. Floor to top of aperture	1675 mm (66 in.) minimum
D. Floor to bottom of aperture	150 mm (57 in.) minimum
E. Vertical dimension of aperture	425 mm (17 in.) minimum

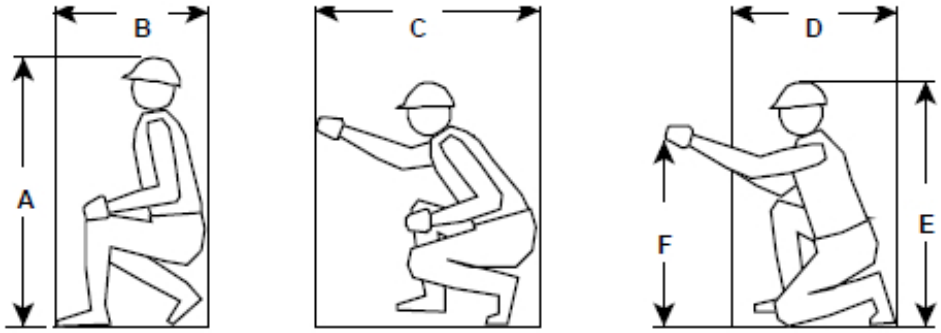
TABLE 10
Standing,
Single Arm Lateral Reach



	Dimensions
A. Depth of reach	650 mm (25 in.) maximum
B. Breadth of aperture	25 mm (10 in.) minimum
C. Floor to top of aperture	1675 mm (66 in.) minimum

D. Floor to bottom of aperture	1450 mm (57 in.) minimum
E. Vertical dimension of aperture	400 mm (16 in.) minimum

TABLE 11
Squatting, Kneeling Space Dimensions



Squatting Work Space:	*Minimum Dimensions*
K. Height	1300 mm (51 in.)
L. Depth	925 mm (6 in.)
M. Depth	1025 mm (40 in.)
Kneeling Work Space:	
N. Depth	1225 mm (48 in.)
O. Height	1550 mm (60 in.)
P. Optimum work point	775 mm (27 in.)

11.3.3 Access Openings

11.3.3(a) General.

Access openings shall be provided, as required, to all equipment or items that require testing, servicing, calibrating, or adjusting. (Category 1 and 2)

Access openings shall be large enough to accommodate hands, arms, and tools and also provide full visual access to the task area. (Category 1 and 2)

Access openings shall be large enough to accommodate hands, arms, and tools and also provide full visual access to the task area. (Category 1 and 2)

11.3.3(b) Dimensions.

The dimensions of access openings for arms and hands (Category 1 and 2) shall be no less than those shown in:

- 4/11.3.3 TABLE 12, “Opening Dimensions for Single Hand Access with Tools”
- 4/11.3.3 TABLE 13, “Opening Dimensions for Single Hand Access without Tools”
- 4/11.3.3 TABLE 14, “Opening Dimensions for Arm Access without Tools”
- 4/11.3.3 TABLE 15, “Opening Dimensions for Two Hands Access”
- 4/11.3.3 TABLE 12, “Opening Dimensions for Single Hand Access with Tools”
- 4/11.3.3 TABLE 13, “Opening Dimensions for Single Hand Access without Tools”

- 4/11.3.3 TABLE 14, “Opening Dimensions for Arm Access without Tools”
- 4/11.3.3 TABLE 15, “Opening Dimensions for Two Hands Access”

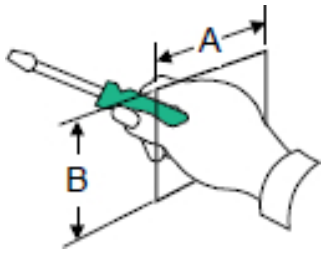
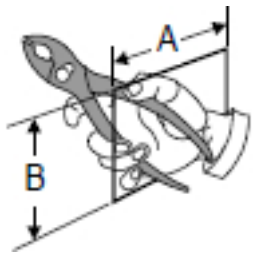
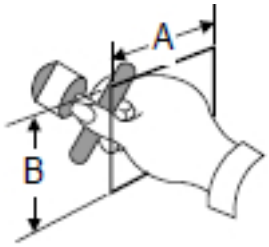
11.3.3(c) Visual Access.

Access openings shall provide full visual access to the task area or an auxiliary viewing port shall be provided through the use of viewing ports or quick release access.

Visual inspections shall be able to be done without use of special tools. (Category 1 and 2)

Visual inspections shall be able to be done without use of special tools. (Category 1 and 2)

TABLE 12
Opening Dimensions for Single Hand Access with Tools

Description of Opening		*Minimum Dimensions mm (in.)*		*Task Description*
		A	*B*	
	Bare Hand	110 (4.25)	120 (4.75)	Using common screwdriver, test probe etc., with freedom to turn hand through 180°
	Gloved	165 (6.5)	180 (7.0)	
	Bare Hand	125 (5.0)	115 (4.5)	Using pliers and similar tools
	Gloved	175 (7.25)	200 (7.75)	
	Bare Hand	150 (6.0)	150 (6.0)	Using “T” handle wrench, with freedom to turn hand through 180°
	Gloved	190 (7.5)	210 (8.25)	

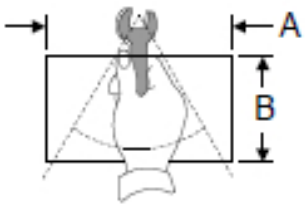
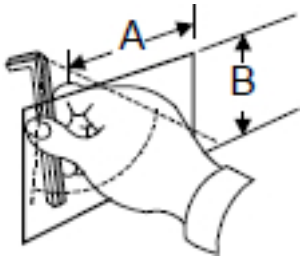
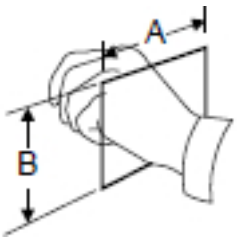
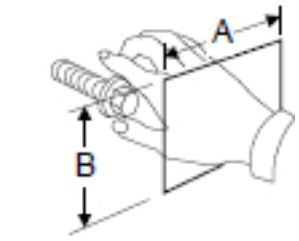
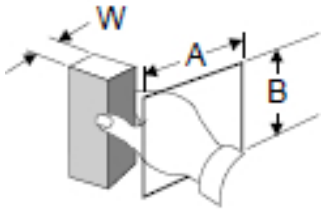
Description of Opening		*Minimum Dimensions mm (in.)*		*Task Description*
		A	*B*	
	Bare Hand	275 (11)	200 (8.0)	Using open-end wrench, with freedom to turn wrench through 60°
	Gloved	325 (12.75)	260 (10.25)	
	Bare Hand	120 (4.75)	150 (6.0)	Using Allen-type wrench, with freedom to turn wrench through 60°
	Gloved	175 (7.0)	200 (8.0)	

TABLE 13
Opening Dimensions for Single Hand Access without Tools

Description of Opening		*Minimum Dimensions mm (in.)*		*Task Description*
		A	*B*	
	Bare Hand	125 (5.0)	100 (3.75)	Empty hand Clenched fist extended to wrist
	Gloved	150 (6.0)	115 (4.5)	
	Bare Hand	100 (4.0)	60 (2.25)	Empty hand Hand flat extended to wrist
	Gloved	150 (6.0)	100 (4.0)	

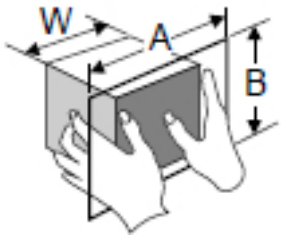
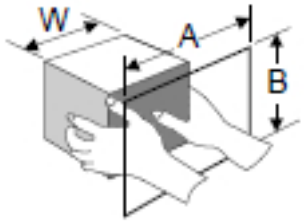
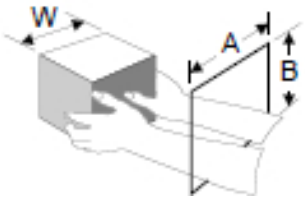
Description of Opening		*Minimum Dimensions mm (in.)*		*Task Description*
		A	*B*	
	Bare Hand	115 (4.5)	120 (4.75)	Grasping small objects (up to 50 mm (2 in.) or more wide) with one hand
	Gloved	170 (6.75)	175 (7.0)	
	Bare Hand	W+45 (W +1.75)	125 (5.0*)	Grasping large objects, 50 mm (2 in.) or more wide with one hand
	Gloved	W+100 (W+4.0)	175 (7.0)	

* Or sufficient to clear part if part is larger than 125 mm.

TABLE 14
Opening Dimensions for Arm Access without Tools

Description of Clothing Type		*Minimum Dimensions mm (in.)*	*Dimension Description*
	Light Clothing	100 mm (4.0 in.) × 115 mm (4.5 in.) or 115 mm (4.5 in.) diameter	Arm to Elbow
	Cold Weather Clothing	180 mm (7.0 in.) square or diameter	
	Light Clothing	125 mm (6.0 in.) square or diameter	Arm to Shoulder
	Cold Weather Clothing	215 mm (8.5 in.) square or diameter	

TABLE 15
Opening Dimensions for Two Hand Access

Description of Opening		*Minimum Dimensions mm (in.)*		*Task Description*
		A	*B*	
	Bare Hand	W+75 (W+3.0)	125 (5.0*)	Grasping large objects with two hands, with hand extended through openings up to fingers
	Gloved	W+130 (W +5.25)	180 (7.0)	
	Bare Hand	W+150 (W+6.0)	125 (5.0*)	Grasping large objects with two hands, with arms extended through openings up to wrists
	Gloved	W+280 (W+11.0)	180 (7.0)	
	Bare Hand	W+150 (W+6.0)	125 (5.0*)	Grasping large objects with two hands, with arms extended through openings up to elbows
	Gloved	W+280 (W+11.0)	180 (7.0*)	

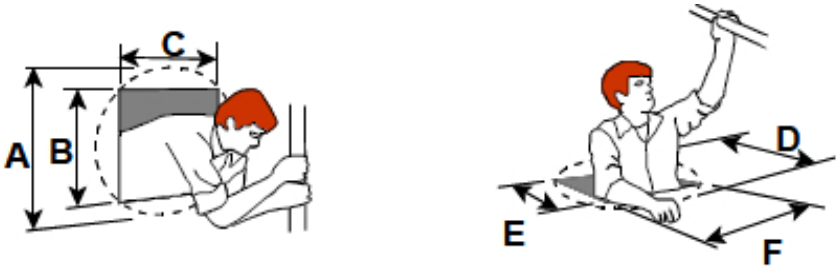
* Or sufficient to clear part if part is larger than 125 mm.

11.3.4 Hatches

Round, square, or rectangular hatches shall be sized as shown in 4/11.3.4 TABLE 16, “Hatch Shapes and Dimensions”. (Category 1 and 2).

Hatch covers above 11 kg (25 lbs)] shall be provided aids for lifting or handling the hatch cover. (Category 1 and 2)

TABLE 16
Hatch Shapes and Dimensions



Access –shape and Dimension		*Minimum*
Side Access		
Round	– A	685 mm (27 in.)
Square		660 mm (26 in.)
Rectangle	– B – C	660 mm (26 in.) 760 mm (30 in.)
Top or Bottom Access		
Round	– D	635 mm (25 in.)
Square		580 mm (23 in.)
Rectangle	– E – F	330 mm (13 in.) 610 mm (24 in.)

11.3.5 Access Aids

Maintenance access requirements are as follows:

i) Permanent barriers such as handrails or guardrails shall be provided to protect routinely-used work stations and maintenance platforms. (Category 1 and 2)

ii) Stairs shall be provided when access is required to elevated work platforms (e.g., mezzanines) one or more times per day. (Category 1 and 2)

iii) Ladders shall not be used when maintainers carry equipment. In all cases, both hands shall be free to grasp and climb ladders. (Category 1 and 2)

iv) Items to be maintained from a ladder shall require only one hand and shall not be located more than 965 mm (38 in.) from the ladder's centerline. (Category 1 and 2)

v) Maintenance on masts or antenna, lights, or other equipment mounted on the mast, or other elevated structures, shall not be performed while suspended by a safety harness, and permanent structural accesses (such as platforms) shall be provided. (Category 1 and 2)

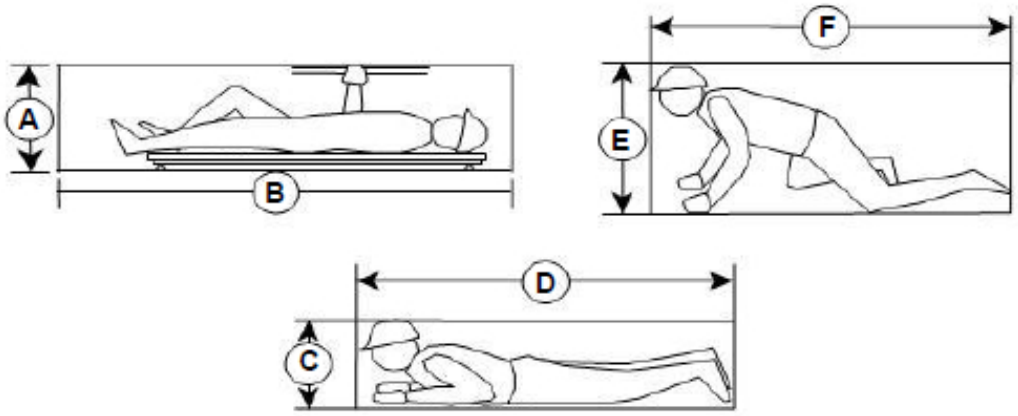
vi) Vertical access shall be provided with adequate clearance. If this is not achievable, masts shall be hinged and able to be lowered for maintenance; otherwise a rotating base shall be provided. (Category 1 and 2)

vii) Portable ladders shall not be used to access permanent work platforms to perform temporary, infrequent maintenance. (Category 1)

11.3.6 Crawlways

Crawl spaces shall conform to the requirements expressed in 4/11.3.6 TABLE 17, "Minimum Dimensions for Crawlways" below. (Category 1 and 2)

TABLE 17
Minimum Dimensions for Crawlways



Supine work space (Lying on Back):	
A. Height – Visual Inspection	350 mm (14 in.)
A. Height – Hand Arm Reach	550 mm (22 in.)
B. Length	1875 mm (74 in.)
Crawling space:	
C. Height	425 mm (17 in.)
D. Length	1525 mm (60 in.)
Prone work or crawl space:	
E. Height	775 mm (31 in.)
F. Length	2875 mm (113 in.)

APPENDIX 1

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APPENDIX 2

Maintenance Task Access Analysis

1 Maintenance Task Access Analysis

1.1 Analysis

An analysis of maintenance tasks is to be performed for the purpose of sizing and outfitting maintenance workspaces. The analysis addresses concerns such as: design of maintenance platforms; work surfaces; work envelopes; tools, spare parts and spent part stowage; and consumables storage at a maintenance site during planned or corrective maintenance.

The analysis is also intended to identify requirements for lifting and carrying devices for heavy or awkward loads; and to facilitate maintenance action work flow.

This analysis is required for all Category 1 and 2 maintenance actions.

1.2 Typical Analysis Steps

A maintenance area task and requirements analysis typically includes the following steps:

1.2.1

List (1) general and frequent maintenance tasks (such as housekeeping and routine or and recurring maintenance), and (2) list major planned maintenance or corrective maintenance actions:

i) Number of participants/maintainers involved for each task

ii) List of major equipment/components to be removed, and replaced, or repaired in place or nearby for each task

1.2.2

For each maintenance task, identify and list the following items requiring space allocation:

i) Consumables (lubricants, adhesives, connectors)

ii) Test equipment, stowed in place and/or portable

iii) Tools or special tools

iv) Replacement parts

v) Need for aided or unaided voice communications

vi) Any required Personal Protective Equipment (PPE)

vii) Lifting aids required

viii) Number of people involved in the immediate maintenance area

ix) Any required procedures, technical manuals, or checklists

x) Whether the maintenance action occurs in a workshop, or directly on installed equipment.

1.2.3

For each maintenance task, estimate and then sum the space requirements. Allocate maintenance work area space based on the analysis, including (where possible) a space allocation margin of 30% or more.

1.2.4

Identify and allocate or fit any requirements for storage surfaces for procedural materials, or ready access to consumables.

1.2.5

Identify requirements for parts and materials carts (for deck level access to maintenance areas), or lifting supports (including overhead crane, chain falls, padeyes, I-beams, etc.) for very heavy components or when in the presence of ramps or stairs to gain maintenance access or transfer. This also requires lifting from one engine room/deck level to another. (For example, from the one engine room deck to another shop level above or below, or from an engine room deck lifting to a maintenance pedestal or platform.

1.2.6

Special space accommodation shall be made for access to, and use of, PPE.

1.2.7

Identify locations of pre-positioned items (such as tools, special tools, consumables) that can be located with the equipment to be maintained.

1.2.8

Develop maintenance area workspace concepts and drawings, considering the above sizing requirements and each maintenance action's activity sequence. This includes provision of suitable space in areas around a piece of equipment (e.g., behind the equipment near a bulkhead) that is needed to remove internal parts, motors, shafts, or attached equipment and the personnel/ equipment required to accomplish these tasks.

1.2.9

Refine the concepts and drawings and prepare them as part of build-to packages.