DEP SPECIFICATION

HUMAN FACTORS ENGINEERING – WORKSPACE DESIGN

DEP 30.00.60.20-Gen.

September 2013

ECCN EAR99

DESIGN AND ENGINEERING PRACTICE

PREFACE

DEP (Design and Engineering Practice) publications reflect the views, at the time of publication, of Shell Global Solutions International B.V. (Shell GSI) and, in some cases, of other Shell Companies.

These views are based on the experience acquired during involvement with the design, construction, operation and maintenance of processing units and facilities. Where deemed appropriate DEPs are based on, or reference international, regional, national and industry standards.

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The information set forth in these publications is provided to Shell companies for their consideration and decision to implement. This is of particular importance where DEPs may not cover every requirement or diversity of condition at each locality. The system of DEPs is expected to be sufficiently flexible to allow individual Operating Units to adapt the information set forth in DEPs to their own environment and requirements.

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1. INTRODUCTION

1.1 SCOPE

This DEP specifies the minimum acceptable Human Factors Engineering (HFE) requirements and gives recommendations for the design and layout of equipment and workspaces. The purpose of this DEP is to ensure the arrangement created in the design allows for efficient and safe access and manual handling during operation and maintenance under all normal, upset/emergency and weather conditions by the full range of potential personnel.

This is a revision of the DEP of the same number dated September 2011; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them. Any authorised access to DEPs does not for that reason constitute an authorization to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in facilities related to oil and gas production, gas handling, oil refining, chemical processing, gasification, distribution and supply/marketing. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process shall be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regards to the safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for it. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

Term	Definition
Anthropometry	The measurement of body dimensions
Critical Task Inventory	An inventory of human tasks, identified by application of DEP 30.00.60.19-Gen., that are considered to be critical to asset integrity or process safety.

Term	Definition
HFE Technical Authority	The individual assigned as Technical Authority for HFE on the project in compliance with Business Unit and Group standards.
Human Factors Engineering	A multidisciplinary science that focuses on the interaction between the human and the work system in order to design human-machine interactions that optimise human and system performance. (ISO 6385)
Operating Aisles	Space for access to equipment and machinery requiring hands-on work by one or more individuals as well as for the use of mobile assisted lifting and transport devices
Thoroughfare	A thoroughfare is a walkway which is routinely used by people passing in both directions, e.g., main access ways or emergency escape routes.
Work platform	A level surface used for the operation, maintenance, inspection, repair, sampling and other phases of work in connection with the equipment or machinery
Walkway	A level surface used for moving from one point to another

1.3.3 Abbreviations

Term	Definition
DN	Diametre Nominal / Nominal Diameter
FFL	Finished Floor Level
HFE	Human Factors Engineering
NPS	Nominal Pipe Size
PPE	Personal Protective Equipment
RPE	Respiratory Protective Equipment
SCBA	Self Contained Breathing Apparatus

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section or clause number is shown in brackets ( ). Other documents referenced by this DEP are listed in (6).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated September 2011. The following are the main, non-editorial changes.

Section/Clause	Change
3.1.1	Table 1, Parameter C - Revised height from 2100 mm to 2300 mm to accommodate European industry and regulatory requirements. (Changed 84 inches to 90 inches in corresponding USC units.)
3.1.4	Table 4 (H) Overhead Clearance. Revised height from 2100 mm to 2300 mm to accommodate European industry and regulatory requirements. (Changed 84 inches to 90 inches in corresponding USC units) Added note to Table 4 – clarifying dimension to be used in USA is 2130 mm (84 in).
3.3.1	Table 11, Optimal Vertical Viewing Arc changed from 800 to 80°.

3.5.1	Head clearance on walkways – clarified different dimension applies depending on regional regulatory requirement. For European regulatory requirements, revised from 2100 mm to 2300 mm to accommodate European industry and regulatory requirements. For USA this dimension is 2130 mm (84 in).
3.5.3	Inserted minimum dimensional requirements for platforms.
3.5.3	Revised clear standing area in front of the ladder from 750 mm to 900 mm (in metric unit only) to accommodate European industry and regulatory requirements.
3.6.1	Revised reference for offshore (US GoM) from ENG0068SP to DEP 37.81.10.31-Gen.
3.6.2	Table 19. Number of editorial and dimensional changes
3.6.2	Removed requirement for three-tier handrails on flair stairs.
3.6.6	Revised requirement for guard/handrails on ramps 610 mm to 500 mm (in metric unit only) to accommodate European industry and regulatory requirements.
3.7.2	Dimension A: Inserted a Note providing clearance requirements if stretcher access is required.
3.8	Revised distance to the primary means of escape from 15 m (50 ft) to 25 m (82 ft) to eliminate conflict with other DEPs.
3.8	Revised length of dead-end from 7 m (23 ft) to 6.1 m (20 ft) to eliminate conflict with other DEPs and regulatory requirements.
5.8	Revised “pipe flange size DN300 (NPS 12)” to read “pipe line size DN300 (NPS 12)”
5.8	Revised “minimum vertical clearance of 460 mm (18 in)” to read “minimum horizontal clearance of 460 mm (18 in)”
5.12	Revised to only address manual sample points for volatile and/or toxic materials.
5.13	Revised the required height for guardrails from 610 mm to 500 mm (in metric unit only) to accommodate European industry and regulatory requirements.
5.13	Reduced size of exposed and unattended floor or deck openings from 300 mm (12 in) by 300 mm (12 in) to 100 mm (4 in) by 100 mm (4 in) because of personal safety considerations
6	Deleted reference to ENG0068SP and replaced with DEP 37.81.10.31-Gen.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the "Give feedback" link, fill in the online form and submit.
DEP Feedback System (Users with access to Shell Wide Web)	Enter comments directly in the DEP Feedback System which is accessible from the Technical Standards Portal http://sww.shell.com/standards. Select "Submit DEP Feedback", fill in the online form and submit.
DEP Standard Form (Other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com.

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

1.7 DUAL UNITS

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

2. GENERAL DESIGN REQUIREMENTS

2.1 PROJECT DESIGN

Where a project/design solution deviates from requirements and data in this DEP, the designer shall obtain approval from the Principal, and is directed to the project or regional Human Factors Engineering (HFE) Technical Authority (TA) as detailed in the Project Controls and Assurance Plan (PCAP) or Discipline Controls and Assurance Framework (DCAF) Discipline Authorities Manual.

2.2 ANTHROPOMETRICS

For the purpose of this DEP, the default anthropometric data used is that of the 5th percentile female Southeast Asia and 95th percentile male Northern European population unless stated otherwise within the document. For variances, projects should seek the assistance of the regional HFE TA for support to establish region specific requirements/data.

Dimensions, where appropriate and depending on the source data, have been rounded off to the nearest 10 mm (0.5 in).

2.3 SAFETY CRITICAL TASKS

It shall be the responsibility of the project to determine the classification/category of safety critical equipment and systems. Designers are directed to DEP 30.00.60.19-Gen. for details on identifying process safety critical tasks.

2.4 CONTROLS AND DISPLAYS

Where stated, the preferred dimensions shall apply to controls and displays that require precise, frequent, and/or emergency use/review.

2.5 LIFE-SAVING RULES

Workplaces shall be designed and laid out to support safe ways of working. Equipment shall not be laid out, or access provided in ways that will make any task (operational, inspection, maintenance or testing) easier or faster by violating a life-saving rule.

2.6 ACCESSIBILITY AND REACH

Items most critical to system operation and which require rapid maintenance shall be most accessible. When relative criticality is not a factor, items requiring most frequent access shall be most accessible. High-failure rate items shall be accessible for replacement without removing non-failed items.

The required reach distance for any given task will vary depending on the task requirements. Assistance of the regional HFE TA should be sought where the data provided may not be commensurate with the task requirements (i.e., manual handling).

At no time shall an operator or maintainer be required to stand on any surface not specifically designed to be used as a standing surface in order to see, reach or perform an anticipated manual operation.

The design of workspaces shall take account of all necessary tools, materials and test equipment required to be used in the workspace.

2.7 POSTURE

The design of workspaces shall take account of the number of personnel required to perform the task, the actions (physical movements and application of force) to be undertaken and the postures that operators will be required to assume.

Kneeling and squatting operator positions should be avoided as much as possible for tasks performed on a regular basis (>1/shift). It is only permitted for maintenance or non-routine and infrequent jobs and where such layouts are unavoidable. These postures should not be

used for tasks that require operators to assume them for extended periods of time or to handle heavy loads or manually apply significant forces.

2.8 PERSONAL PROTECTIVE EQUIPMENT

As PPE will be specified on a regional and case by case basis, the designer should refer to the appropriate Operations personnel, HSSE representatives and HFE TA to identify task/project specific PPE and any potential impacts this may have on design: i.e., breathing apparatus (BA).

3. WORKSPACE ENVELOPE - MINIMUM REQUIREMENTS

3.1 STANDING POSITION

3.1.1 Minimal working volume

As a minimum, adequate standing workspace shall be provided wherever an operator or maintainer is required to work. The minimum dimensions of this space shall be as shown in Figure 1 and Table 1.

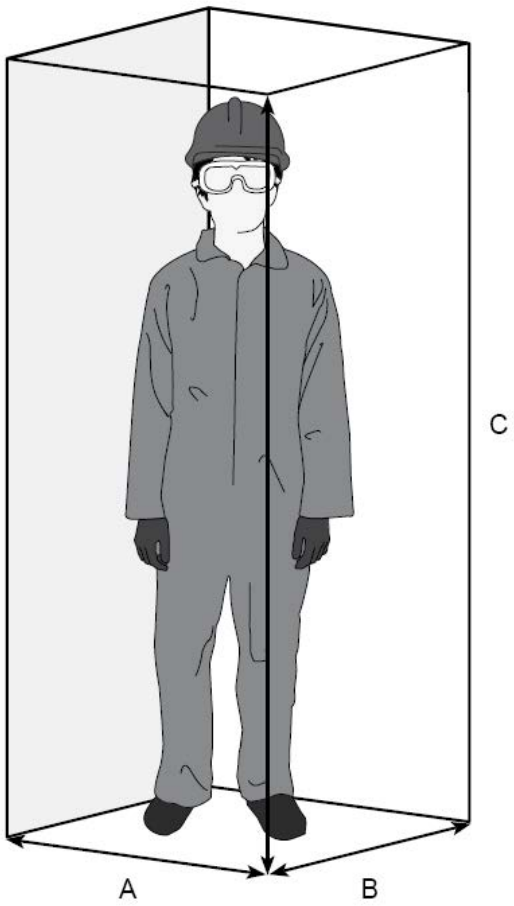


Figure 1 Minimal working volume in a standing posture

Table 1 Minimal working volume dimensions in a standing posture

Parameter		Minimum Dimensions*
A	Width	1000 mm (39 in)
B	Depth	1000 mm (39 in)
C	Height§	2300 mm (90 in)

NOTES: * There will be exceptions, e.g., for the purpose of determining sizes of muster areas or individual standing room at embarkation stations on offshore/marine facilities. The width and depth dimension should be reduced to 610 mm (24 in). Designers are directed to their regional HFE TA, for exceptions. These dimensions, furthermore, have been corrected for various types of PPE (i.e., Cold Weather clothing and SCBA).

§ For USA, this minimum height dimension shall be 2130 mm (84 in). For other regions, the Principal shall specify the appropriate dimension.

3.1.2 Standing and control surfaces

Displays, indicating instruments, mimic panels and controls mounted vertically or on flat vertical surfaces for use by standing operators shall be located as shown in Figure 2, and accompanying Table 2.

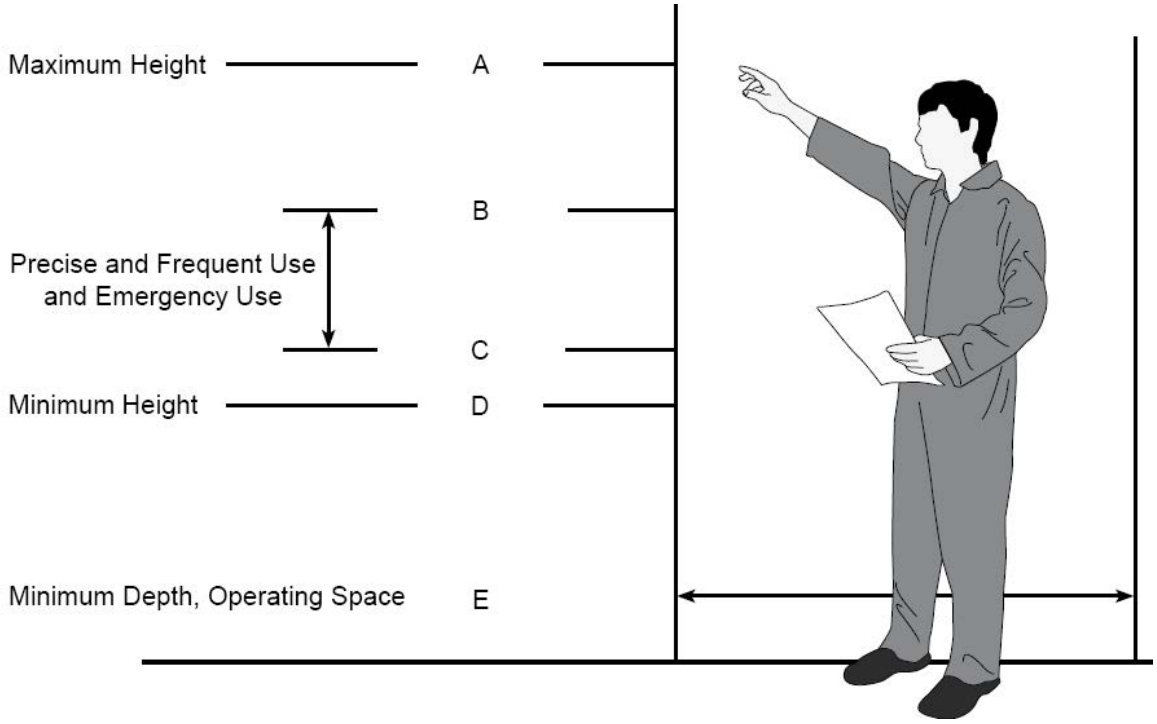


Figure 2 Control mounting height for standing personnel

Table 2 Control mounting heights – Standing

Parameter		Dimensions
A	Maximum reach height (Overhead pinch grip of 5th percentile female)	1770 mm (70 in)
B	Preferred maximum reach height (Shoulder height of 5th percentile female)	1160 mm (46 in)
C	Preferred minimum height (Hand grip height of 95th percentile male)	870 mm (34 in)
D	Minimum height (Knee height of 95th percentile male)	540 mm (21 in)
E	Minimum depth or clearance in front of panel/console/cabinet façade, where no work or interactions require the operator to squat or kneel down to a lower level	910 mm (36 in)

NOTE: All standing dimensions include 25 mm (1 in) allowance for foot-wear.

Maximum effective forward reach (i.e., ability to grasp and turn/push/pull forward) shall be 460 mm (18 in) from the front of the operator's body.

3.1.3 Standing and display surfaces

Displays, indicating instruments, and mimic panels mounted vertically or on flat vertical surfaces for use by standing operators shall be located as shown in Figure 3, and accompanying Table 3.

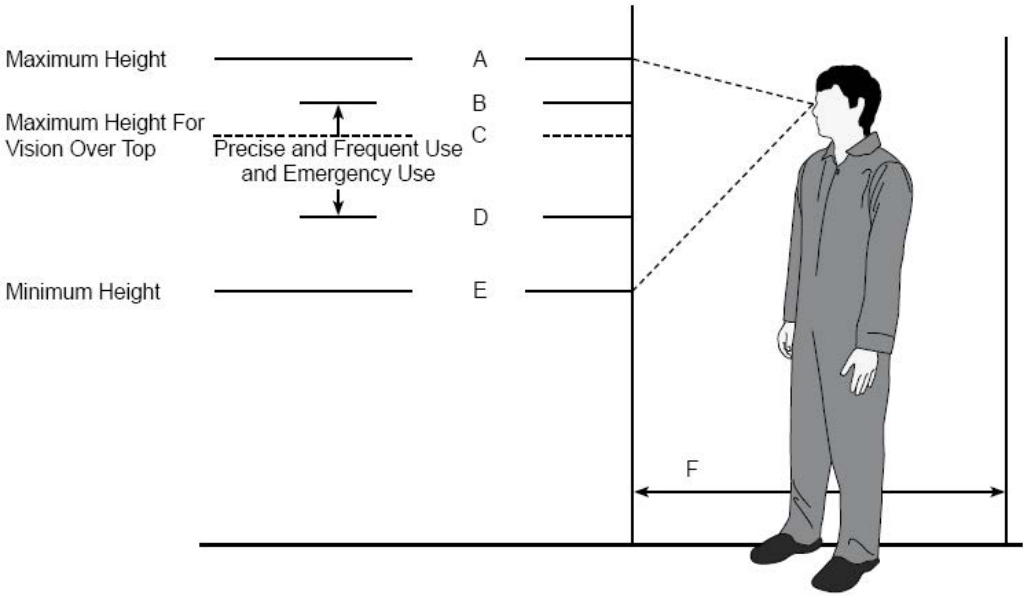


Figure 3 Display mounting height for standing personnel

Table 3 Display mounting heights – Standing

Parameter		Dimensions
A	Maximum height (Standing eye height of 5th percentile female wearing shoes, upward viewing angle of 25° above horizontal and 830 mm (32 in) viewing distance)	1730 mm (68 in)
B	Preferred maximum height (Standing eye height of 5th percentile female wearing shoes, upward viewing angle of 25° above horizontal and 500 mm (20 in) viewing distance)	1590 mm (63 in)
C	Maximum height for vision over the top	1460 mm (57 in)
D	Preferred minimum height (Standing eye height of 95th percentile male wearing shoes, downward viewing angle of 55° below horizontal and 500 mm (20 in) viewing distance)	1390 mm (55 in)
E	Minimum height (Standing eye height of 95th percentile male wearing shoes, downward viewing angle of 55° below horizontal and 830 mm (32 in) viewing distance)	1120 mm (44 in)
F	(Minimum depth or clearance in front of panel/console/cabinet façade, where no work or interactions require the operator to squat or kneel down to a lower level)	910 mm (36 in) for all regions

NOTE: 1. All standing dimensions include 25 mm (1 in) allowance for footwear.
2. Dimensions A to E are from FFL.

3.1.4 Standing and work benches

The dimensions of standing work benches shall comply with those shown in Figure 4 and Table 4.

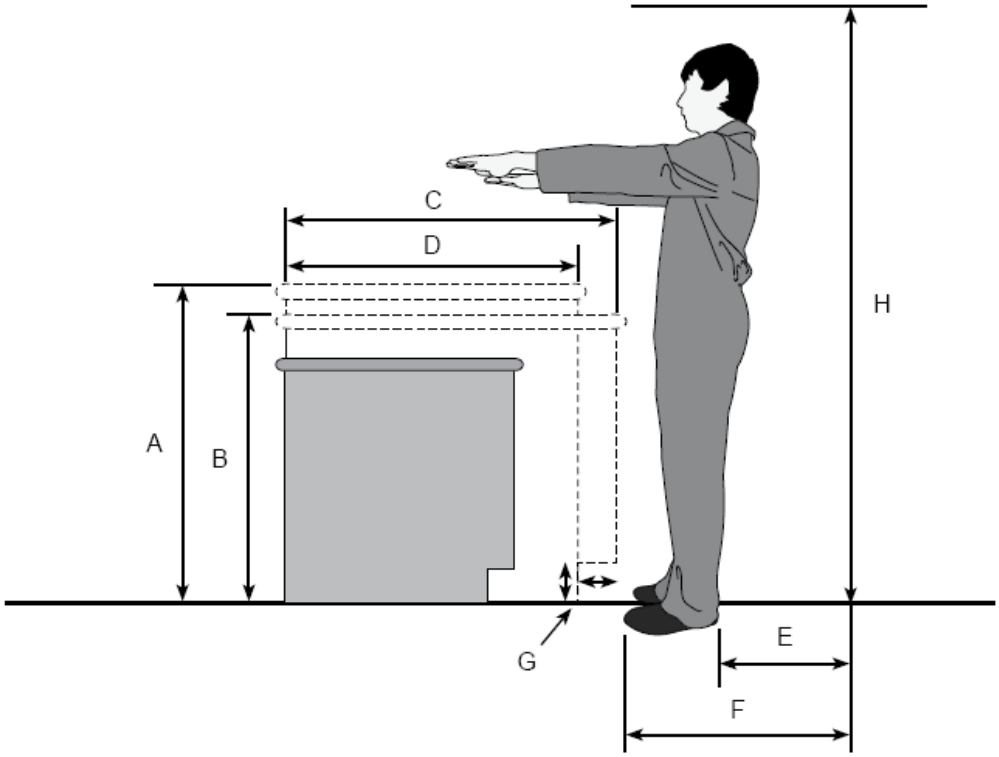


Figure 4 Standing workbench configuration

Table 4 Standing workbench dimensions

		Height Above Floor			Max Depth	
Standard Bench (Standing)	**B**	**910 mm**	**(36 in)**	**C**	**1020 mm**	**(40 in)**
Example: Laboratory bench or work bench in machinery shop for maintenance of valves.						
Tall Bench	**A**	**1020 mm**	**(40 in)**	**D**	**910 mm**	**(36 in)**
Example: Laboratory bench or work bench for fine detail inspection or maintenance.						
		Minimum			**Preferred**	
Passing Width behind Body	**E**	**460 mm**	**(18 in)**	**E**	**610 mm**	**(24 in)**
Working Space	**F**	**810 mm**	**(32 in)**	**F**	**910 mm**	**(36 in)**
Foot Space (square)	**G**	**100 mm**	**(4 in)**			
Overhead Clearance	**H***	**2300 mm**	**(90 in)**			

NOTE: * Dimension “H” denotes the standing overhead clearance required for the height of the body in front of a work bench and is based on European regulatory requirements for headroom or clearance. For USA, this dimension shall be 2130 mm (84 in) minimum. For other regions, the Principal shall specify the appropriate dimension.

3.1.5 Standing and shelving

Workspace clearances required for use of shelves with full frontal access in offices and warehouses shall be as shown in Figure 5 and Table 5.

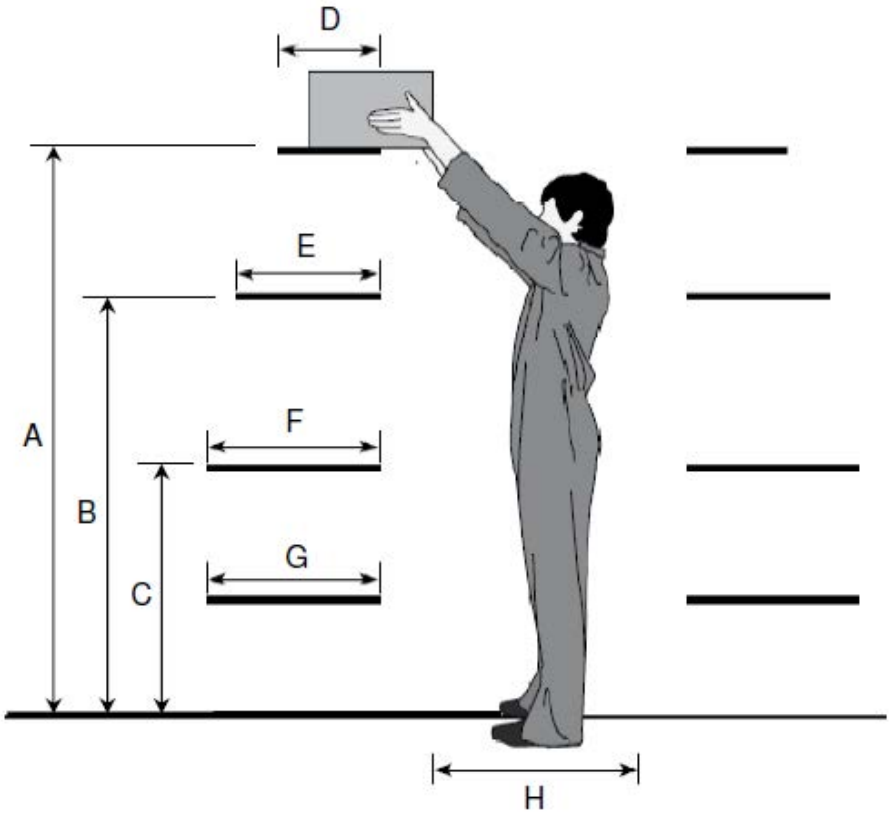


Figure 5 Workspace dimensions for shelves with full access

Table 5 Shelf heights and depths

Parameter		Dimensions
A	Maximum Shelf Height	1960 mm (77 in)
B	Intermediate Shelf Height	1630 mm (64 in)
C	Lower Shelf Height	1220 mm (48 in)
D	Depth of Shelves at A	360 mm (14 in)
E	Depth of Shelves at B	510 mm (20 in)
F	Depth of Shelves at C	610 mm (24 in)
G	Shelf Depth below C	610 mm (24 in)
H	Space Between Shelves	Shelf width plus 100 mm (4 in) or 660 mm (26 in), whichever is greater.

NOTE: Dimensions A, B and C are from FFL.

Shelves located above a cabinet shall be designed per Figure 6 and Table 6 below.

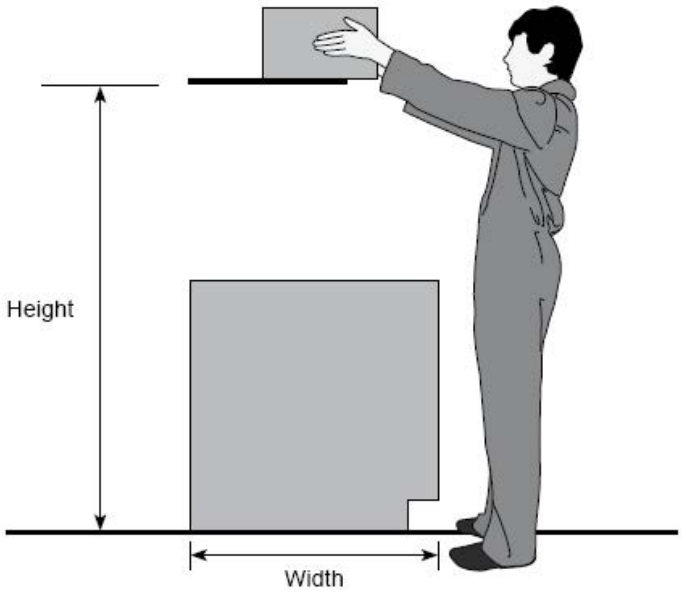


Figure 6 Shelving access above cabinets

Table 6 Shelf height in relation to cabinet width

Cabinet Width	**Maximum Shelf Height (From FFL)**
360 mm (14 in)	1910 mm (75 in)
610 mm (24 in)	1800 mm (71 in)
800 mm (31.5 in)	1700 mm (67 in)

Clearance required in front of lower shelves in order to place large items on them shall be as shown in Figure 7 and Table 7 below.

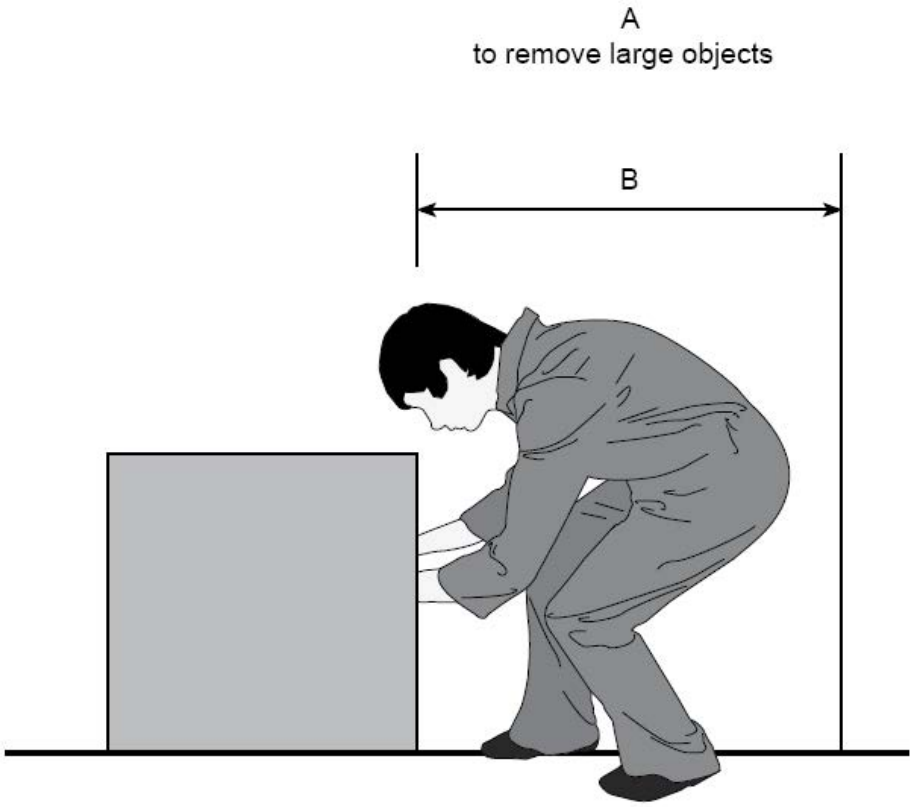


Figure 7 Front clearance requirements for lower shelves to remove large objects

Table 7 Access required for lower shelves and the removal of large objects

Parameter		**Dimension**
A	Space Required to Remove Large Objects	1020 mm (40 in)
B	Space Required to Access Lower Shelves	910 mm (36 in)

3.2 SQUATTING POSITION

3.2.1 Minimal working volume

The minimum workspace required for operators to undertake manual tasks from squatting postures shall be as shown in Figure 8 and Table 8 below.

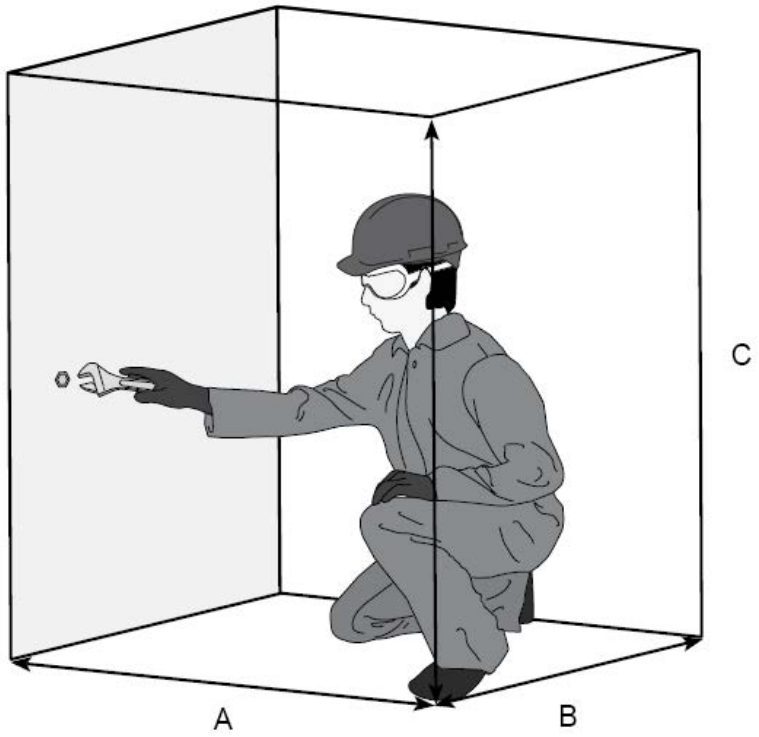


Figure 8 Required dimensions for a squatting worker

Table 8 Required dimensions for a squatting worker

Parameter		Minimum Dimensions
A	Width	1300 mm (51 in)
B	Depth	1300 mm (51 in)
C	Height	1300 mm (51 in)

NOTE: These dimensions have been corrected for various types of PPE (i.e., Cold Weather clothing and SCBA). Designers are directed to their regional HFE TA.

3.2.2 Squatting and control surfaces

Controls mounted in the vertical or on vertical, flat surfaces for use by squatting operators shall be located as shown in Figure 9 and Table 9.

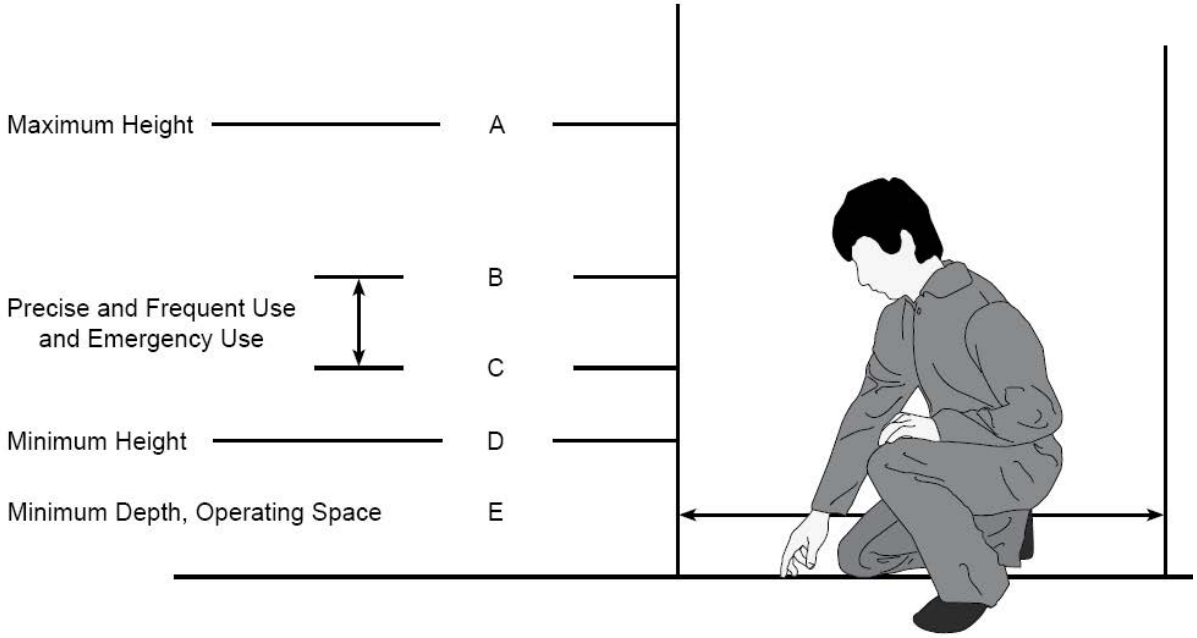


Figure 9 Access to controls from a squatting posture

Table 9 Control mounting heights for squatting personnel

Parameter		**Dimension**
A	Maximum Height	1190 mm (47 in)
B	Preferred Maximum Height	790 mm (31 in)
C	Preferred Minimum Height	430 mm (17 in)
D	Minimum Height	380 mm (15 in)
E	Minimum Depth	910 mm (36 in)

NOTE: Measurements A to D taken from FFL.

3.2.3 Squatting and displays

Displays or indicating instruments mounted in the vertical or on vertical, flat surfaces for use by a squatting operator shall be located as shown below in Figure 10 and Table 10.

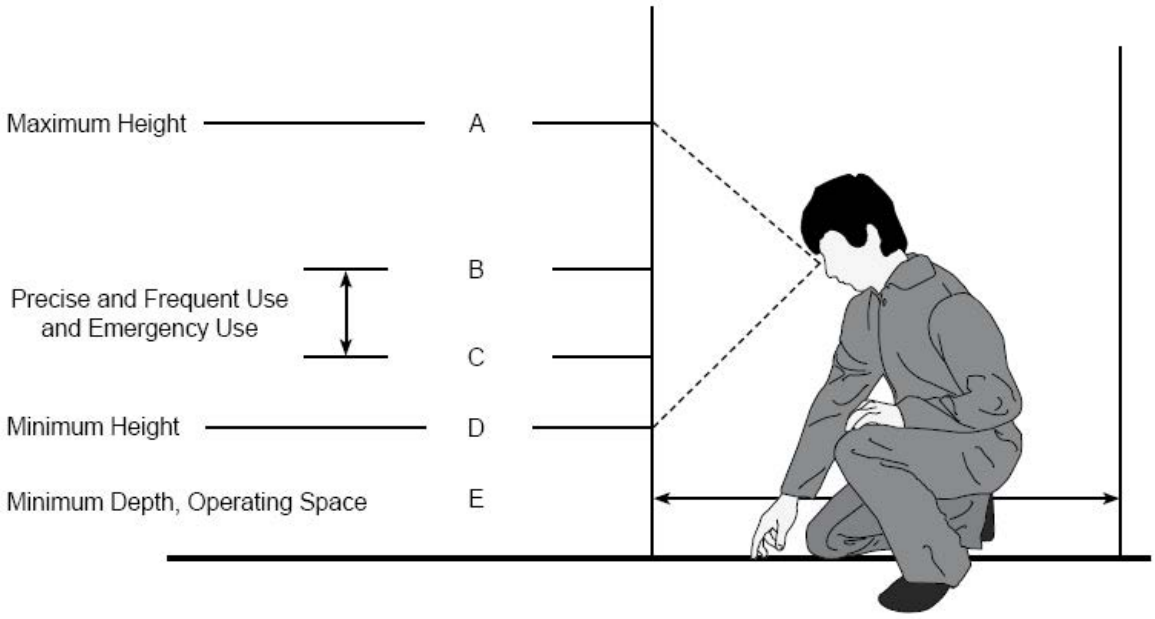


Figure 10 Access to displays from a squatting posture

Table 10 Display mounting heights for squatting personnel

Parameter		**Dimension**
A	Maximum Height	1190 mm (47 in)
B	Preferred Maximum Height	940 mm (37 in)
C	Preferred Minimum Height	670 mm (26 in)
D	Minimum Height	530 mm (21 in)
E	Minimum Depth	910 mm (36 in)

NOTE: Measurements A to D taken from FFL.

3.3 SEATED POSITION

3.3.1 Minimal workspace volume and preferred viewing angles

1. Adjustable work surface height and viewing distances shall be provided to all anchored personnel especially if the user population is highly variable in size. Height adjustability can be via installer, crank or power. Figure 11 through Figure 14 and Table 11 show key dimensions for adjustable workstation design.

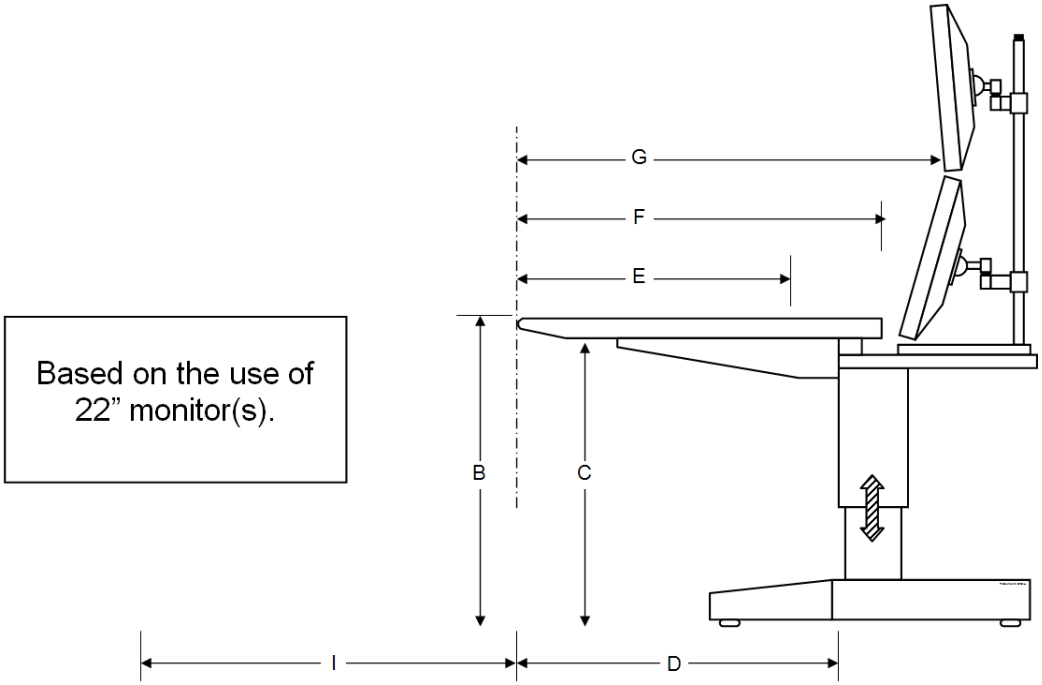


Figure 11 Main anthropometric design criteria – adjustable workstation

Table 11 Minimum anthropometric design criteria – Adjustable workstation

Parameter – to be determined for project:		**Dimensions**
A	Seated eye-height – 5th percentile female to 95th male range to be accommodated	940 – 1340 mm (37 – 53 in)
	Optimal Vertical Viewing Arc	80°
B	Work surface height range – determined from seated elbow height range of 5th percentile female to 95th percentile male	610 – 790 mm (24 – 31 in)
C	Minimum range of height/clearance of underside of work surface – determined by popliteal plus thigh height of seated 95th percentile male	500 – 720 mm (20 – 28 in)
D	Minimum clearance for feet, legs, knees – there shall be no obstructions whatsoever – determined from 95th male data	450 mm (18 in) at the knees, and 600 mm (24 in) at the feet
E	Maximum reach distance – determined by 5th percentile female	500 mm (20 in)
F	Minimum depth of workstation/console work surface	760 mm (30 in)
G	Minimum/maximum distance to screen	Min – 500 mm (20 in); max – 830 mm (33 in) However, maximum distance is dependent on, and should be checked against, the system's display character heights.
H	Minimum horizontal workspace per individual	760 mm (30 in)
I	Clearance from workstation to obstacle behind	1070 mm (42 in)

2. Fixed height workstations should be considered if space or other constraints make adjustable work surface heights impractical such as for laboratory benches/tables.
3. Fixed height workstations should be considered if the workstation is only used occasionally and for limited time periods (<2 hours) by any individual or mobile operator. These also include "Touchdown, Hotel or Phone Booths" within the office environment.
4. The height shall be 760 mm (30 in) or as required to comply with national and/or local regulations.
5. The following should apply to vertical and horizontal viewing angles for single and double tier monitor arrangements.

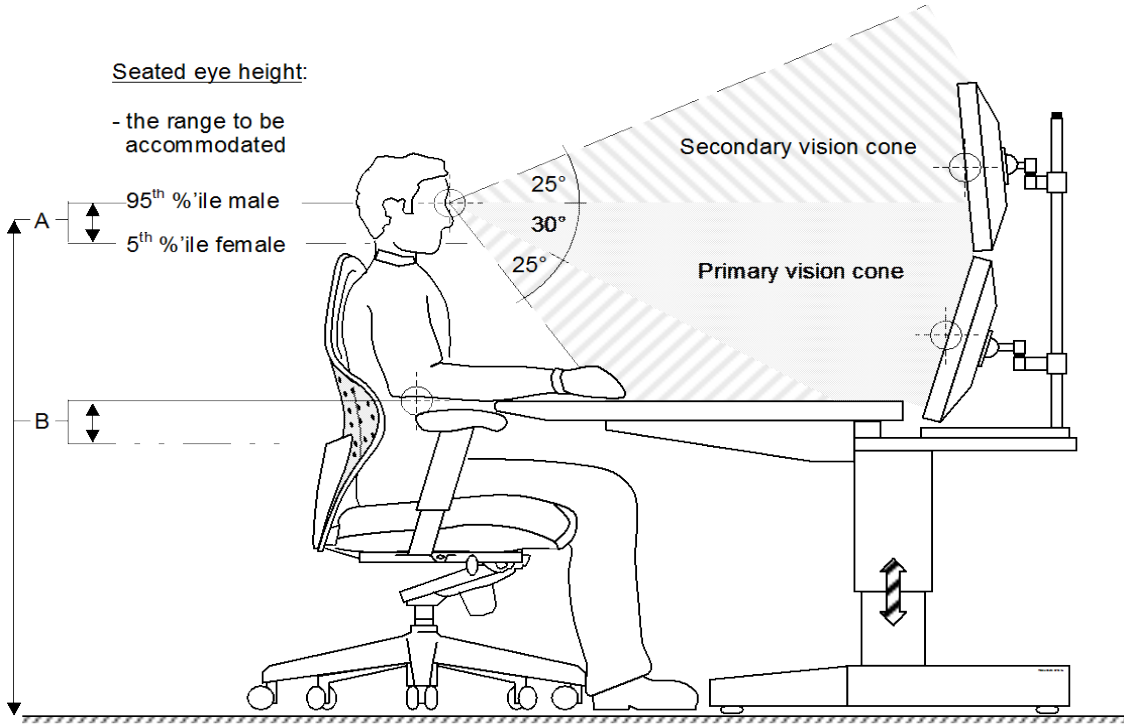


Figure 12 Optimal vertical visual zone and double-tier arrangement (The design criteria in Table 11 apply.)

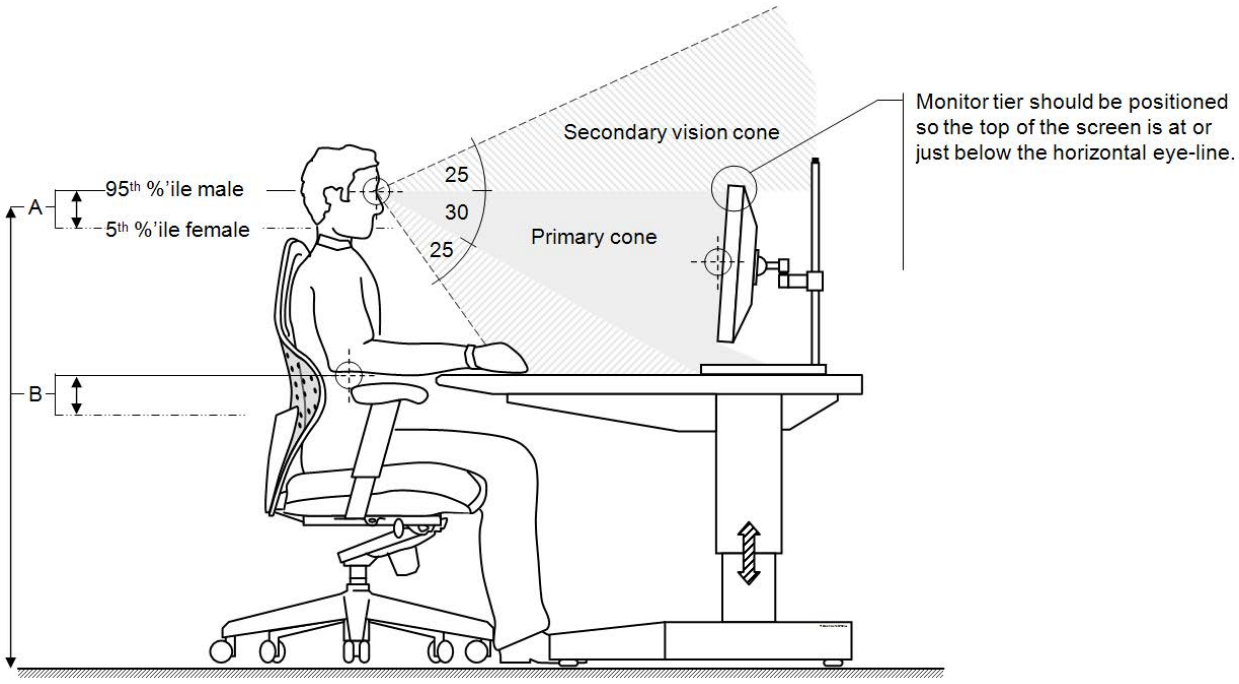


Figure 13 Optimal vertical visual zone and single-tier arrangement (The design criteria in Table 11 apply.)

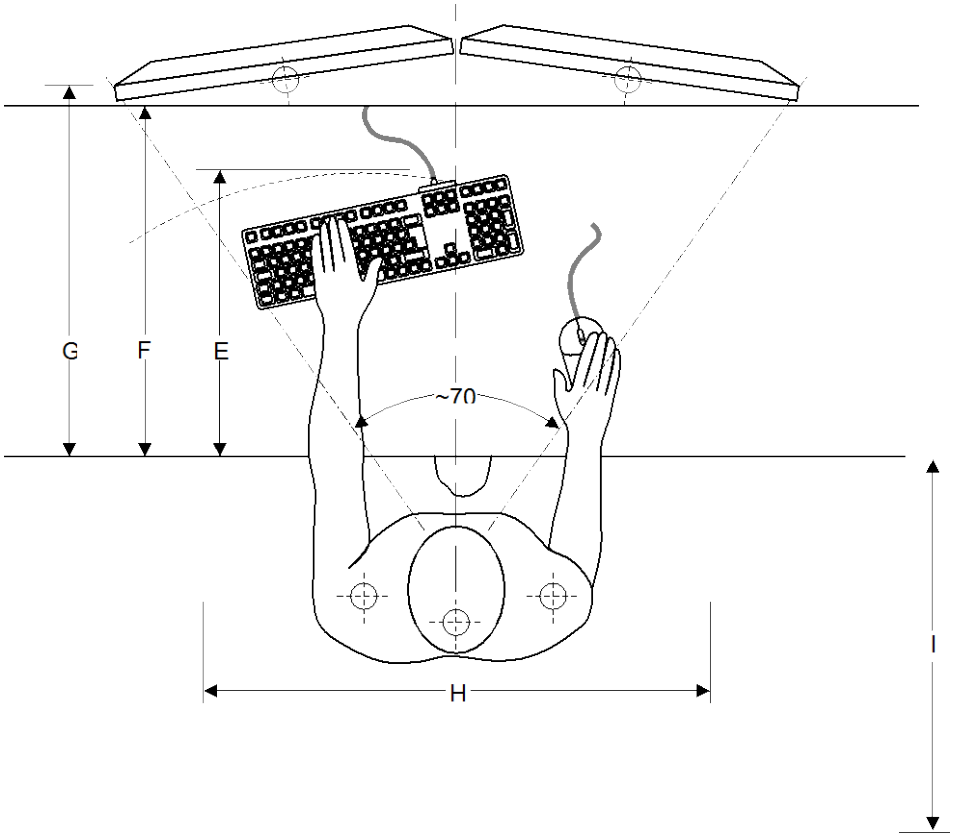


Figure 14 Optimal horizontal visual zone – Plan view (Refer to Table 11 for dimensions.)

The space required for a work surface depends on the task, kind of documents, computer and other equipment that will be used. The following minimum sizes for computer workstations or desks shall apply:

- Standard desk for anchored persons: 1370 mm (54 in) wide X 760 mm (30 in) deep.
- Call Centre: 1150 mm (45 in) wide X 760 mm (30 in) deep.
- Touchdown/Hotel or Phone Booth: 760 mm (30 in) wide X 610 mm (24 in) deep.

For single or multiple persons sitting at conference tables or other non-desk types of workstation (i.e., not undertaking any specific operational or safety critical tasks), the dimensions shown in Figure 15 shall be provided.

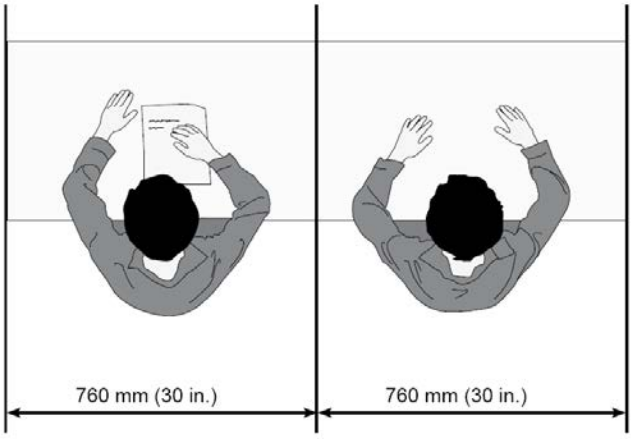


Figure 15 Dimensions for multiple personnel at a table or other work station not requiring a desk (minimum)

The minimum required width of a walkway behind a seated worker or between two seated workers shall comply with the data provided in Figure 16 and Table 12 below.

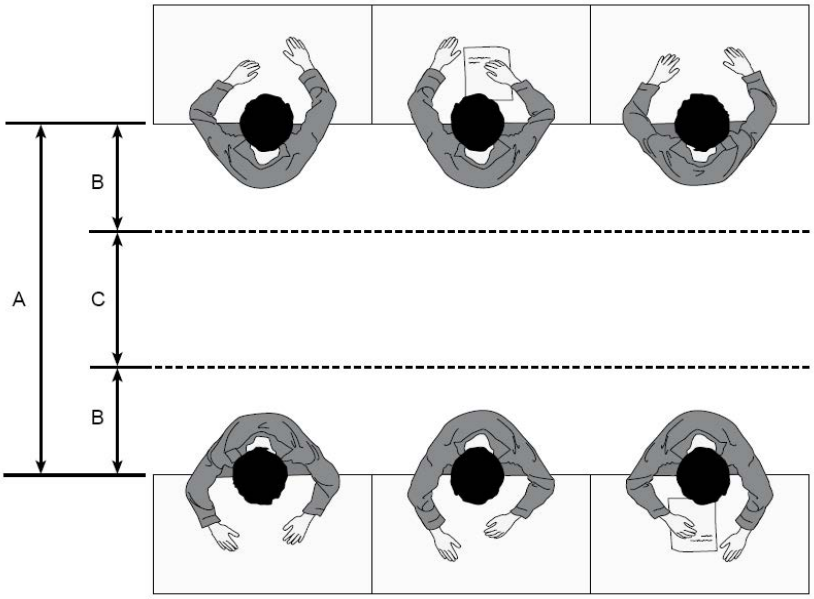


Figure 16 Minimum dimensions for a seated individual and walkway width behind them

Table 12 Minimum dimensions for a seated individual and walkway width behind them

Parameter		Dimensions
A	Width between Workstations	2540 mm (100 in)
B	Space Allowance for Seated Operator	810 mm (32 in)
C	Width between Seated Operators	910 mm (36 in)

3.3.2 Seated and control surfaces

Mounting heights for controls located on vertical, flat surfaces accessible from a seated position shall be as shown in Figure 17 and Table 13 below.

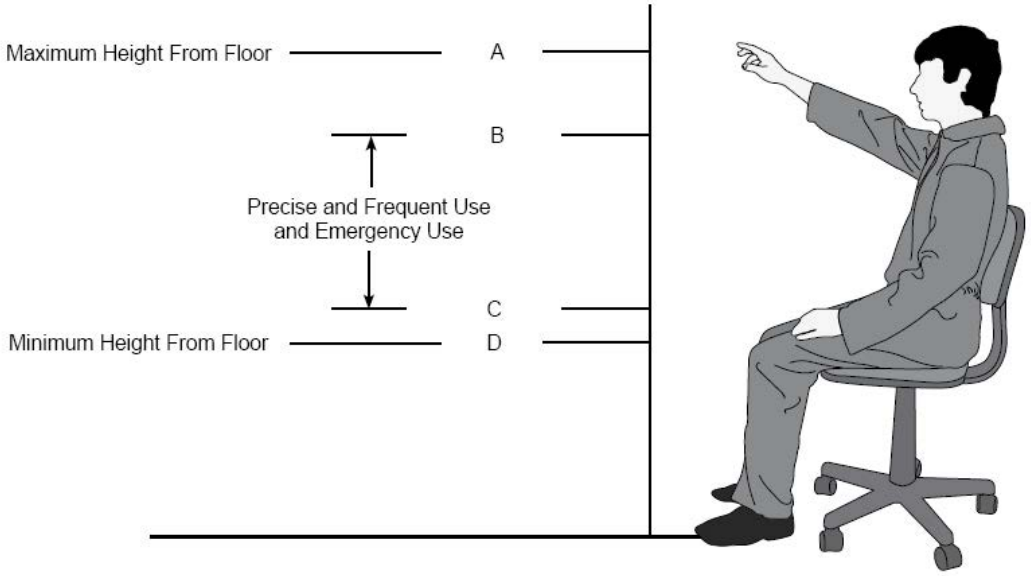


Figure 17 Vertical access to controls from a seated position

Table 13 Control mounting height for seated position

Parameter		Dimension
A	Maximum Height.	1400 mm (55 in)
B	Preferred Maximum Height.	1140 mm (45 in)
C	Preferred Minimum Height.	580 mm (23 in)
D	Minimum Height.	530 mm (21 in)

3.3.3 Seated and displays

Mounting heights for displays located on vertical, work surfaces shall be as shown in Figure 18 and Table 14.

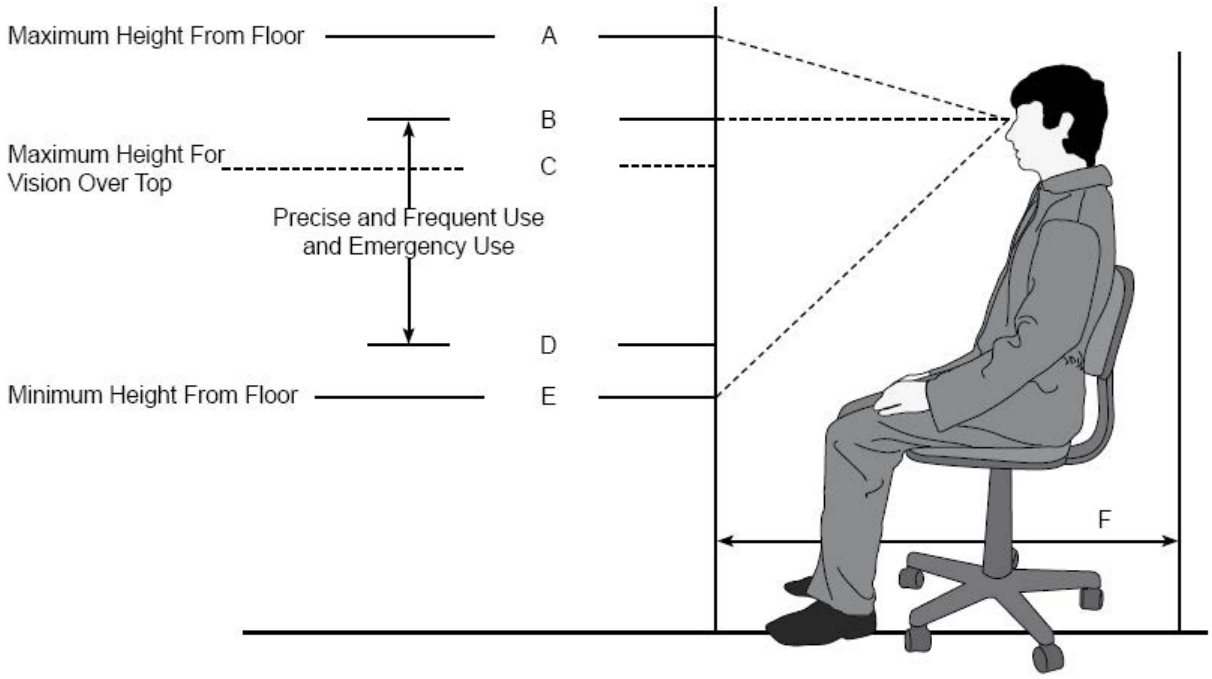


Figure 18 Visual access to displays from a seated position

Table 14 Display mounting height for seated position

Parameter		Dimension
A	Maximum Height	1450 mm (57 in)
B	Preferred Maximum Height	1210 mm (48 in)
C	Maximum Height for Vision Over Top	990 mm (39 in)
D	Preferred Minimum Height	710 mm (28 in)
E	Minimum Height	510 mm (20 in)
F	Minimum Workspace Depth	1070 mm (42 in)

3.3.4 Seated and overhead reach

Where overhead reach is required by a seated operator for operation of a control, the maximum overhead extended reach (e.g., for pushing a button) and effective reach (e.g., for grasping a knob or turning a handle) heights shall be as shown below in Figure 19 and Table 15.

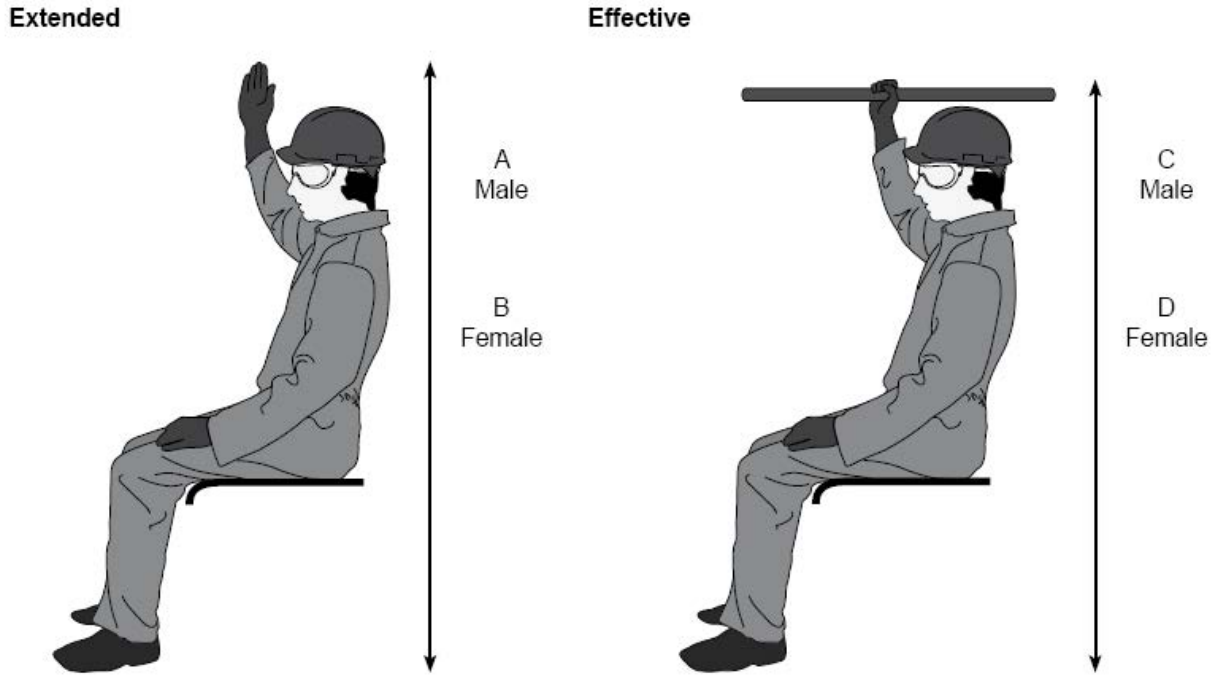


Figure 19 Overhead reach for a seated person (measured from the top of the seat pan)

Table 15 Dimensions for vertical reach for operators in seated positions

Parameter		Dimension
A	Maximum extended vertical reach for seated male operators.	1680 mm (66 in)
B	Maximum extended vertical reach for seated female operators.	1440 mm (57 in)
C	Maximal effective reach for seated male operators.	1630 mm (64 in)
D	Maximal effective reach for seated female operators.	1400 mm (55 in)

3.4 SPECIAL WORKING POSITIONS

3.4.1 Supine, prone and crawling

Workspaces for supine, prone and crawling postures shall be specified as shown in Figure 20 and Table 16 below.

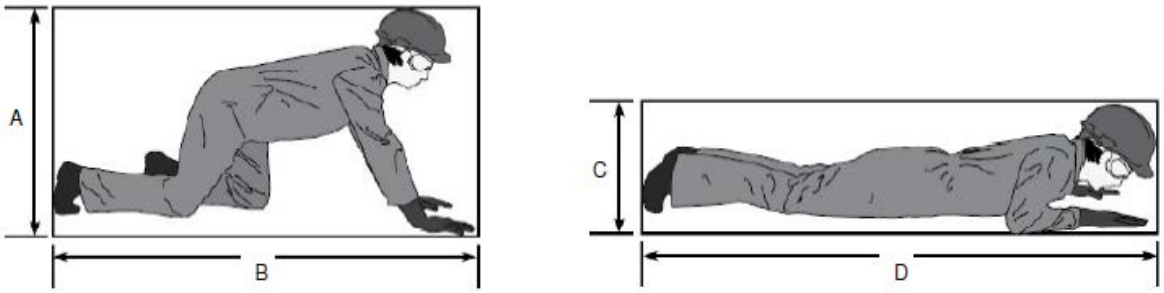


Figure 20 Access dimensions for special working postures

Table 16 Clearance dimensions for special working positions

		Minimum		Preferred		Including Cold Weather PPE	
		mm	in	mm	in	mm	in
Crawling Space:							
A	Height	810	32	910	36	970	38
B	Length	1520	60	1780	70	1780	70
Prone Work or Crawling Space:							
C	Height	510	20	610	24	760	30
D	Length	2500	98	2500	98	2500	98

Preferred dimensions shall be used unless approved by regional HFE TA.

3.5 HORIZONTAL ACCESS

3.5.1 Walkways

Walkway width shall make suitable provisions for operators and maintainers wearing PPE, RPE and winter clothing and also the carriage of tools and equipment.

Walkway widths shall comply with the dimensions and applications shown in Table 17.

Table 17 Walkway widths

Application	Minimum Dimension
One person walking sideways in restricted area (e.g., machinery space, skid packages, etc.) without bulky clothing	600 mm (24 in)
One person travelling forward in area with limited access	750 mm (30 in)
Walkways (or thoroughfares) usually subject to passage or crossing of several persons simultaneously, OR Corridor or passageway which serves as a required exit in temporary accommodation	900 mm (36 in) 1000 mm * (39 in)*
Operating aisles within process areas OR External walkways designated as escape routes on offshore facilities OR Route inside the permanent accommodations module, buildings, or other areas where 50 or more persons could congregate, that serves as an emergency exit from manned spaces	 1200 mm (48 in) 1500 mm * (60 in)*

NOTE: *For colder climates requiring personnel to wear cold weather PPE.

For compliance with European regulatory requirements, there shall be a minimum of 2300 mm (90 in) of head clearance provided above the walking surface for the full length and width of all walkways, at the access point of an area and around equipment, valves, etc. where operators pass.

For USA, this dimension shall be 2130 mm (84 in) minimum.

For other regions, the Principal shall specify the appropriate dimension.

3.5.2 Walking surfaces

Walking surfaces shall:

- be even at all joints to eliminate tripping hazards, and
- have sufficient traction (i.e., slip-resistance) to allow workers to move on it safely.

Unless otherwise stated, solid flooring shall be used only for interior or other applications free of precipitation or frequent wetting. Grating may be used for both interior and exterior applications.

All ragged edges, welds, protruding bolts, or other fasteners that might cause injury to personnel shall be avoided, or if required, ground smooth.

3.5.3 Elevated work platforms and decks

Where practical, pressure vessels that are grouped together shall have platforms and interconnecting walkways at the same elevation.

At no time shall an operator or maintainer be required to stand on any surface not specifically designed to be used as a standing surface. Work platforms may be used to meet this requirement.

Permanent platforms shall typically be provided where items are not accessible from the surrounding facilities. Examples of locations requiring platforms shall include, but not be limited to, the following:

a) Access to equipment inspection or service opening, such as manholes;

b) Access to equipment which requires inspection, adjustment or servicing during operations, such as control valves and level controls;

c) Access to valves on towers or equipment elevated above an appropriate operational level;

d) Platforms shall also be provided at locations where access deteriorates due to weather conditions or maintenance activities, such as a tank pad slope that becomes slippery during winter.

Any elevated equipment where the tasks being undertaken require the use of both hands shall be provided with a work platform. This will provide operators/maintainers with a stable standing surface that does not require them to stand on stair treads or ladder rungs while performing work. Valve hand wheels greater than 120 mm (5 in) are considered to be a two-handed operation.

Elevated work platforms shall be designed to provide space and support for live loads as per DEP 34.00.01.30-Gen., where:

- temporary storage or lay down of blinds where blinding is expected to occur and there is no spectacle blind installed,
- the lay down of heavy and/or large vessel internals and machine parts during maintenance activities,
- the placement of tools, spare parts, and/or equipment preparatory to, and during the task, and
- temporary storage of catalyst, desiccants, etc. prior to loading vessels as required.

Work platforms, furthermore, should be located and sized to allow for the number of workers involved performing the tasks, and:

- in whatever posture is necessary to accomplish the tasks,
- without having to assume an awkward or unsafe body posture, and
- without having to manipulate equipment, tools and internals beyond the guard/handrail.

NOTE: Use minimum workspace requirements from (4) for determining the appropriate size of platforms. Where necessary, the input of the regional / project HFE TA should be sought to identify the appropriate task requirements with the assistance of Operations or Maintenance for determining appropriate sizing.

Platforms shall not be less than 760 mm (30 in) wide and 760 mm (36 in) deep, except that platforms which are used exclusively for standing (e.g., just to reach a valve) shall be no less than 610 mm (24 in) wide and 610 mm (24 in) deep.

Platforms used to access a vertical ladder shall provide a minimum clear standing area of 900 mm (36 in) in front of the ladder measured from the front of the ladder stringer to the inside of the platform handrail opposite the ladder, or to the back edge of the platform if there is no handrail.

A side-step platform shall be no more than 150 mm (6 in) from the edge of the ladder stringer when a climber safety system is used.

Walkways on elevated work platforms for vessels/columns/towers (except storage spheres) shall provide a minimum of 750 mm (30 in) clear access between any object (including insulation and cladding) and the guardrail. See Figure 21 and associated Table 18.

For additional information on guardrails, see (5.13).

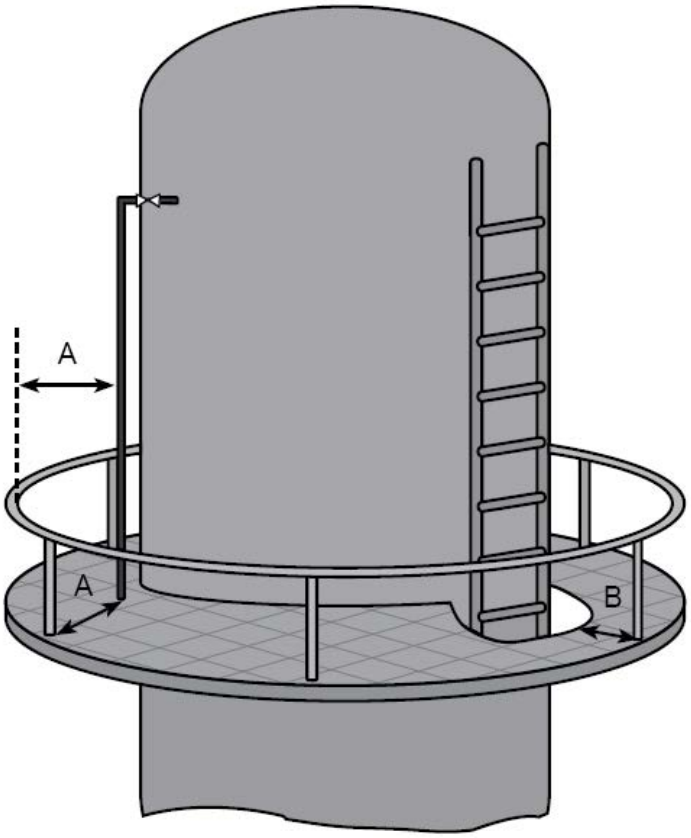


Figure 21 Vessel access platform widths

Table 18 Vessel access platform widths

Parameter		Dimension
A	Access Width	750 mm (30 in) 1000 mm (39 in)*
B	Access Width	600 mm (24 in)

NOTE: *For colder climates requiring personnel to wear cold weather PPE.

3.6 VERTICAL ACCESS

3.6.1 General

The final selection of the vertical access approach to be used to move from one walking or working surface to another (i.e., stair, vertical ladder, or ramp) shall be based on the purpose, frequency of use, and height of the vertical access change required. Vertical access, however, shall be provided whenever operators or maintainers must change elevation abruptly by more than 300 mm (12 in).

Stairways shall be provided for access to and egress from elevated work platforms, walkways, and other elevated work areas where the frequency of use is once per shift or more. This excludes stand-alone vessels or columns/towers not located in supporting structures.

Non-permanent means of access (e.g. portable ladders, scaffolding, mobile elevated work platforms, personnel lift) may be acceptable when the frequency and criticality of access is low. The nature of the tasks (e.g. the need to apply high level of force; tasks requiring fine manual skills; speed and frequency; set-up time; number of hard-to-reach places), the work environment, hazards to the worker health and safety, implications of human error on process safety, and costs are relevant factors to be taken into account when deciding on non-permanent means of access.

The design should allow for planned access, sufficient clearances and space, and compliance with necessary HFE Health and Safety requirements to accommodate personnel, tools, parts, and crane or other equipment access for removal.

Stairs and vertical ladders shall meet the requirements of DEP 34.28.00.33-Gen. and DEP 37.81.10.31-Gen., for onshore and offshore (US GoM), respectively.

3.6.2 Stairs

Stairways are required for access to elevated work platforms, walkways, and other elevated work areas where the frequency of use is once per shift. If access requirement is less than once per shift, then stairways shall be provided as follows:

- if access is required to Category 1 valves, all battery limit valves and associated blinds, vents and drains, or
- if the access is on main operating levels and main service levels, or
- where material, tools or other equipment must be carried for operations and/or maintenance, or
- there is a potential for exposure to hazardous chemicals or materials (e.g., H_2S) at the elevated location.

Stair tread and riser dimensions shall vary depending on the angle of inclination but all other stair dimensions shall be consistent regardless of angle of inclination. These dimensions shall be within the range shown in Figure 22 and Table 19 below, unless otherwise identified in regulatory requirements which supersede this specification.

The angle of inclination shall be the angle necessary to provide equal riser heights and tread depths throughout each stair run, while complying with the dimensions shown in Figure 22 and Table 19 below.

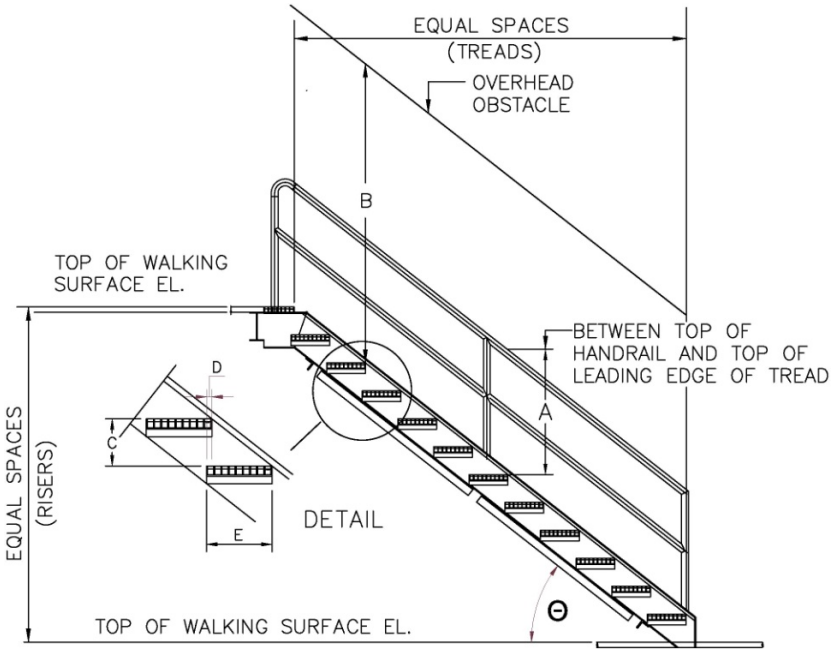


Figure 22 Stair configuration

Table 19 Stair dimensions

Parameter		Dimension	
		Minimum	**Maximum**
Angle of Inclination θ		**30°**	**40°**
A	Handrail Height *	900 mm (36 in)	1000 mm (39 in)
B	Overhead Clearance ¥ (Headroom)	2300 mm (90 in)	2300 mm (90 in)
C	Riser Height	180 mm (7 in)	200 mm (8 in)
D	Overlap Þ	≥10 mm (0.4 in)	25 mm (1 in)
E	Tread Depth (excluding overlap)	310 mm (12 in) §	240 mm (9.5 in) ₸

NOTES: * Guardrails, if required, shall be provided in addition to handrails

¥ For USA, this dimension shall be 2130 mm (84 in) minimum. For other regions, the Principal shall specify the appropriate dimension.

Þ For USA, this dimension shall be 22 mm (7/8 in) minimum

§ Maximum tread depth dimension combined with minimum riser height to provide 30° stair angle

₸ Minimum tread depth dimension combined with maximum riser height to provide 40° stair angle

For any given run of stairs, all riser heights shall be equal throughout the length of the stairs including the top and bottom treads and shall comply with the requirements shown in Table 19. Riser heights can change from one stair run to another, but an effort should be made to make all stair runs uniform in design throughout the facility or structure.

Equal tread depths shall be provided throughout each stair run and shall comply with the dimensions shown in Table 19. The tread depth shall include an overlap (nosing) between the back of the lower tread and the front of the tread immediately above. Tread depths can change from one stair run to another, but an effort should be made to make all stair runs uniform in design throughout the facility or structure.

The top tread shall be flush with the walking surface to which the stair is attached. If there is coaming at the top of the stair, the top tread shall be flush with the top of the coaming and shall extend to the coaming.

Exceptions to the above riser height and tread depth may be considered, if there is insufficient area to install a stair with the required angle of inclination, riser height, and tread depth dimensions shown in Table 19. Any exception should be reviewed by an HFE TA.

The leading edge of each tread shall be coloured with a strip at least 38 mm (1.5 in) in width made with a slip-resistant material. Where the stair treads and/or deck grating is yellow, the leading edge shall be painted a bright red. Where the stair tread and/or deck is brown fibreglass, galvanized steel or painted gray, the leading edge shall be painted a bright yellow, except where the stair is above a yellow painted surface like a hull column top, or alongside a yellow hull column, etc. In this case, it shall be painted a bright red.

The surface of treads on exterior stairs shall be constructed of open steel grating, fibreglass grating, or shall be covered with flat plate treated with slip-resistant material. All stair tread grating material shall meet the requirements of DEP 34.28.00.33-Gen. for onshore applications and DEP 37.81.10.31-Gen. for offshore (US GoM) applications. In cold climates where snow or ice may build up, all tread surfaces shall be open steel grating.

Stairs should be pinned at the top and bottom for easy removal in locations where removable stairs would enhance ease of equipment removal for maintenance or replacement. However, stairs that serve as a required means of egress in emergencies shall be permanently installed.

Individual steps, comprised of tread surfaces only, should be attached directly to a structure (e.g., bulkhead) to change vertical elevations where a stair or vertical ladder is not practical. All dimensions for such steps shall comply with the stair treads described in Figure 22, Table 19, and Table 20 except that the maximum riser height for a single individual step is 300 mm (12 in).

Handrails shall be 38 mm (1.5 in) NPS pipe. Square or angle iron handrails shall not be used. A 75 mm (3 in) minimum clearance shall be provided between the back of the handrail and the nearest object to the rail.

Flare boom stairs shall not exceed an angle of inclination of 45° and do not require intermediate landings when positive climber fall protection is provided. Flare stair tread width shall be 610 mm (24 in) at a minimum.

Table 20 outlines the stair widths that shall be required for various locations and uses, unless otherwise identified in regulatory requirements which supersede this specification.

Table 20 Stair widths for various locations

Location	**Minimum width (inside handrails)**
Stairs serving the accommodations module, buildings, or other areas where 50 or more persons could congregate	1220 mm (48 in)
Stairs on stair towers and in the path of a major egress routes in process areas OR Other two-way stairs or stairs requiring stretcher access in process areas	1120 mm (44 in) 1250 mm (48 in)*
One-way stairs where stretcher access is not required OR For access to seldom used spaces or spaces where maintenance access is required such as around machinery	750 mm (30 in) 1000 mm (39 in)*

* For colder climates requiring personnel to wear bulky winter clothing.

For the staircases of new buildings, the minimum width between handrails shall be 1220 mm (48 in).

Based on hazard and occupancy, a sufficient number, of stairways and ladders shall be provided to meet safety (maximum distance) requirements, especially where platforms and interconnecting walkways (at a common elevation above operating level) connect pressure vessels that have been grouped together.

Spiral stairs shall not be permitted except on tanks or other round structures whose diameter is greater than 2440 mm (96 in), and where a normal stair design is inappropriate. Spiral stairs shall not be used in the wave zone on offshore facilities.

The spiral stair should ascend in a clockwise direction to allow the stair handrail to be on the right-hand side during descent.

3.6.3 Vertical ladders

Ladders shall be located so the maximum distance from the edge of the ladder to any reachable object shall not exceed 610 mm (24 in). Tasks performed at this maximum distance shall only involve simple adjustments or such tasks as can be performed with light tools and one hand while the other maintains a grip on the ladder, i.e., maintaining three points of contact.

Ladders, used by workers to access a work area to perform tasks that require the use of two hands, shall be provided with a work platform (to allow the use of both hands and provide a stable standing surface).

Vertical fixed ladders should be oriented so that a person faces the structure or vessel while climbing.

No vertical ladder shall interfere with the movement or removal of any item.

Vertical ladders used to access tank openings or pressure vessel man-ways, or any other opening equipped with a hinged cover, shall be located so the cover swings away from the ladder.

3.6.4 Self closing safety gates

A self-closing safety gate shall be installed at the top of each ladder. Safety gates shall open/close in the horizontal direction, be self-closing double bar type and cover the full width of the opening between the ladder stringers.

The top bar of the safety gate shall be at the same height as the top rail of the guardrail.

Safety gates shall be able to resist the weight of a 91 kg (200 lb) person in both the vertical and horizontal direction.

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

A single metal bar that opens vertically or chains, wire rope, or other non-rigid barriers, shall not be used.

Safety gates and associated toe plates shall be distinguishable and visually distinct from their surroundings. Ideally, they should be yellow in colour and, incorporate any required signage and markings as dictated by local operating requirements.

3.6.5 Climber safety systems

Climber safety systems shall be provided on all vertical ladders used to travel between two adjacent standing surfaces with a vertical separation exceeding 6.1 m (20 ft), or where a climber could fall overboard, onto equipment or other decks.

Safety cables or rails secured to personnel wearing a safety harness are considered to be positive fall protection devices, but cages alone shall not be positive fall protection devices. The ladders shall also be equipped with a safety cage, if required by the regulator, above 3.7 m (12 ft).

Of the two types of climber safety devices (that is, cable and stainless steel flat bar rail), the cable is preferred although stainless steel flat bar rails are acceptable. Two safety slides, which fit onto the cable or over the bar and hook to the climber’s safety harness, shall be provided for each climber safety device.

Stowage for the harness/harnesses and safety slides should be provided in a central location for easy access.

Harnesses used with the safety system shall be full-bodied and secured at the chest and legs.

For step-through ladders, the system shall be fitted on the side, rather than the centreline, of the rungs to allow enough space for manoeuvrability.

Climber safety systems shall run continuously beginning 900 mm (36 in) above the standing surface at the bottom of the vertical ladder up to 1370 mm (54 in) above the surface of the upper landing.

Emergency escape ladders, from elevated work platforms, upper decks, building tops, equipment skids, etc., to operating level, decks and areas above the splash zone, do not require the inclusion of a climber safety system.

However, they must have the following:

- Cage protection
- Identification by means of a sign with these characteristics:
  - red lettering on a white background
  - placed on or next to the top and bottom of the ladder
  - sign should state “Emergency Escape Ladder”
- Comply with (3.8) of this Specification.

3.6.6 Ramps and sloped walkways

The design of ramps shall comply with regional legal regulation regarding access for mobility impaired persons.

Ramps should be used for changing from one walking or working surface to another when the following conditions exist:

- When the change in vertical elevation is less than 610 mm (24 in),
- When it is necessary to move people, vehicles, or materials via a single technique rather than through individual vehicle ramps and personnel stairs.
- When a ramp would allow more efficient personnel egress along an emergency access/egress route, as long as the angle of inclination is 7° or less.
- When a person is hand-carrying bulky loads or loads in excess of 13.6 kg (30 lb).

Depending on the ramps/sloped walkway intended usage, the following inclines shall apply as per Table 21 below.

Table 21 Recommended ramp and sloped walkway inclines

Ramp use	Recommended incline in degrees
Pedestrian Traffic without Materials Handling	8° (Preferred) – 15° (Maximum)
Pedestrian Traffic with Materials Handling	4° (Preferred) – 7° (Maximum)

Ramp configurations and dimensions shall be based on task requirements. Regional HFE TA should be sought to identify appropriate requirements.

Ramps used for movement of all manual or self-propelled material-handling carriers or vehicular movement shall provide a minimum clear width of 610 mm (24 in) on each side of the carrier or vehicle.

Pedestrian ramps in excess of 4° angle of inclination shall have slip-resistant surfaces.

Ramps in excess of 10° of inclination should have cross-cleats that shall be spaced 360 mm (14 in) preferred, 410 mm (16 in) maximum, apart and extend the full width of the ramp at right angles to the direction of travel.

For projects having to comply European regulatory requirements, handrails shall be provided on any open side of a ramp provided the vertical distance from the ramp to the nearest adjacent surface below the ramp is 500 mm (20 in) or higher.

For USA, this dimension shall be 610 mm (24 in). For other regions, the Principal shall specify the appropriate dimension.

3.7 MANWAYS

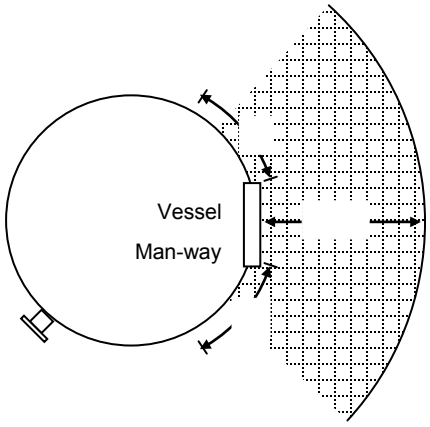
3.7.1 General

The design of manways and other access/egress apertures shall take into account the following in their design and positioning:

- Accommodating the protective equipment (i.e., PPE, RPE, weather resistant clothing, etc. that the operator will be required wear under normal and emergency operating conditions.
- The carriage of tools, equipment and materials.
- Where the anthropometric data for local user population differs significantly from Northern Europeans population, the regional / project HFE TA should be sought.

3.7.2 Access clearances

Clearances around manways shall be as per Figure 23 below.



A	1220 mm (48 in)	Minimum clearance in front of manway*
B	750 mm (30 in)	Minimum clearance either side of manway

NOTE: Stretcher access requires 1830 mm (72 in) clearance in front of the manway for evacuation.

Figure 23 Clearances around manways

Circular manways (requiring full body access) on pressure vessels shall be as per Table 22 below.

Table 22 Sizing for circular manways on pressure vessels

Pressure vessels/columns/reactors with a minimum diameter of:	Minimum manway (nozzle) inside or clear diameter shall be:
< 610 mm (24 in)	If full body access is required, then provide top or end-break flange, instead of a nozzle type manway
610 mm – 1220 mm (24 in. – 48 in)	DN 450 (NPS 18), with DN 500 (NPS 20) preferred*
> 1220 mm (48 in)	DN 500 (NPS 20), with DN 600 (NPS 24) preferred*
	If top entry is required on vertical or horizontal vessels then minimum size shall be DN750 (NPS 30) to accommodate ladders*

* When determining the appropriate manway size, the designer shall consider pertinent task requirements such as installing/removal of vessels internals, safety and emergency egress requirements, clothing including PPE and RPE.

Vessel/column tray access openings or manways shall have a minimum diameter of 460 mm (18 in) with 610 mm (24 in) preferred if circular. For rectangular tray access openings, the minimum size shall be 320 mm (13 in) x 500 mm (20 in).

Circular vessel skirt openings (requiring full body access) have the following requirements:

- For vessels up to 1200 mm (48 in) in diameter, the opening shall have a minimum inside clear diameter of 500 mm (20 in)
- For vessels larger than 1200 mm (48 in.) in diameter, the opening shall have minimum clear inside diameter of 600 mm (24 in) with 750 mm (30 in) being preferred.
- Oval (elliptical or obround) vessel skirt openings shall be 460 mm (18 in) by 800 mm (32 in) minimum.

Dimensions for opening requiring full body access shall be as per Figure 24 and Table 23 below. The round opening dimension is not intended to apply to pressure vessel manways.

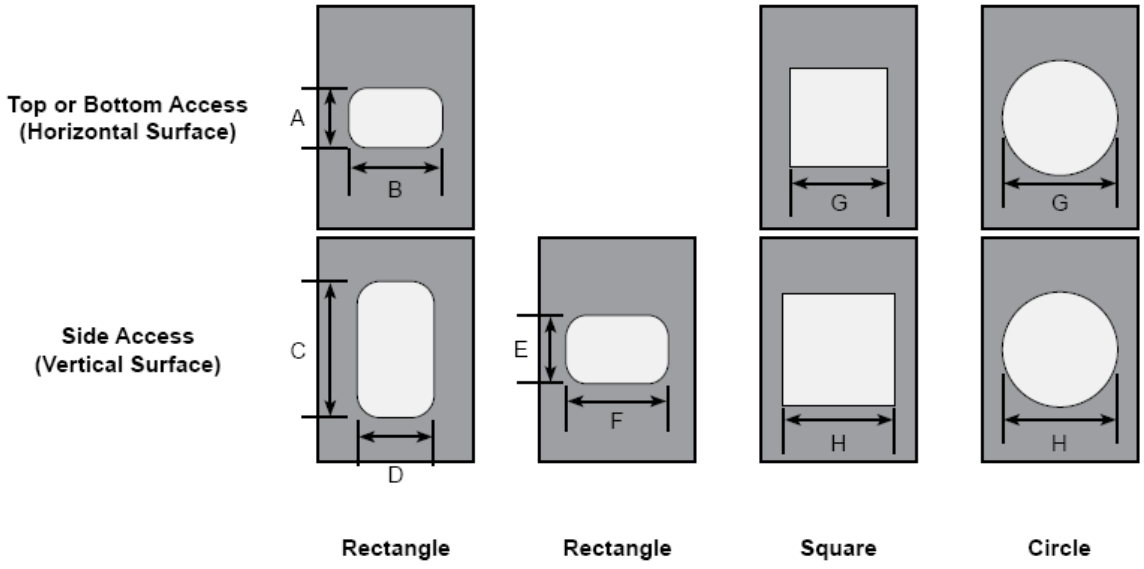


Figure 24 Dimensions for rectangular, square and round openings in vertical and horizontal orientations

Table 23 Minimum dimensions for rectangular, square and round openings in vertical and horizontal orientations

Hatch Shape	Rectangle			Square			Circle		
Clothing		**Light**	**Bulky**		**Light**	**Bulky**		**Light**	**Bulky**
Top Entry (Horizontal Surface)	A	360 mm (14 in)	460 mm (18 in)	G	580 mm (23 in)	690 mm (27in)	G	690 mm (27 in)	810 mm (32 in)
	B	560 mm (22 in)	660 mm (26 in)						
Side Entry (Vertical Surface)	C	810 mm (32 in)	990 mm (39 in)	H	660 mm (26 in)	790 mm (31 in)	H	690 mm (27 in)	810 mm (32 in)
	D	460 mm (18 in)	560 mm (22 in)						
	E	410 mm (16 in)	550 mm (21 in)						
	F	610 mm (24 in)	710 mm (28 in)						

Dimensions for lightening holes (a hole cut in the plating, usually in inter-bottom tanks or void tanks to reduce the weight of the structure and provide an access opening for maintenance of the inside of the tanks) shall be as per Figure 25 and Table 24 below.

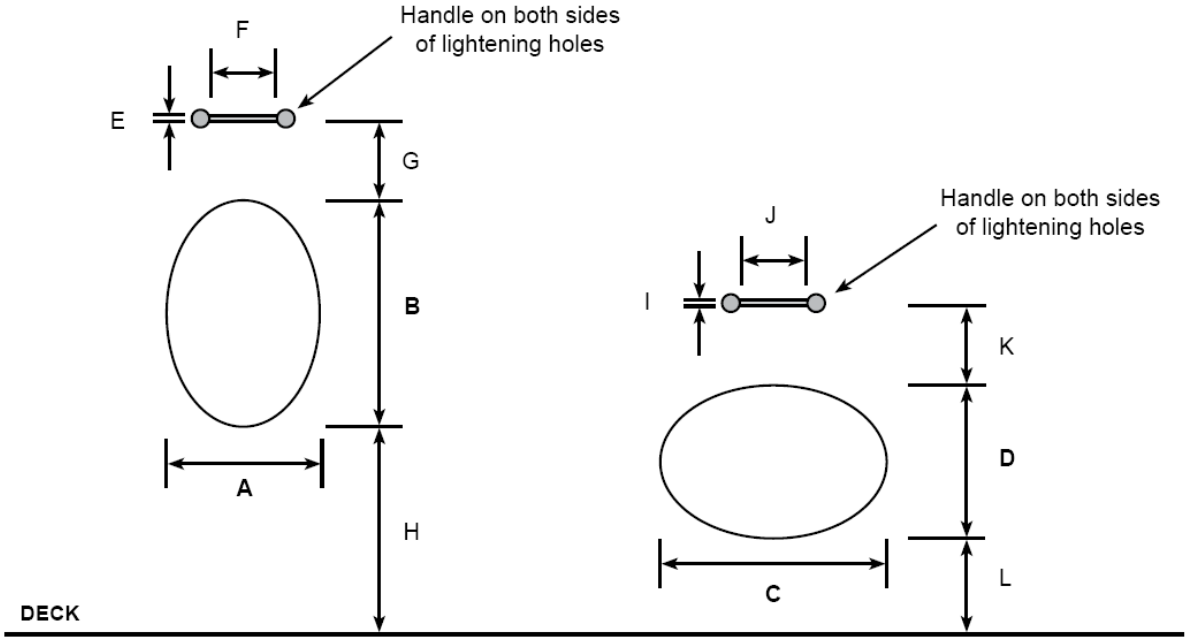


Figure 25 Dimensions for lightening holes

Table 24 Dimensions for lightening holes

Parameter		Dimension	
		Minimum	**Preferred**
A	Vertical Oval Width	460 mm (18 in)	560 mm (22 in)
B	Vertical Oval Width	810 mm (32 in)	990 mm (39 in)
C	Horizontal Oval Width	660 mm (26 in)	760 mm (30 in)
D	Horizontal Oval Height	430 mm (17 in)	530 mm (21 in)
E	Handle Height (Vertical Oval)	N/A	13 mm (1/2 in)
F	Handle Width (Vertical Oval)	N/A	150 mm (6 in)
G	Separation Between Top of a Vertical Oval and Underside of Handle	N/A	300 mm (12 in)
H	Separation Between the Deck and Bottom of a Vertical Oval	N/A	710 mm (28 in)
I	Handle Height (Horizontal Oval)	16 mm (5/8 in)	25 mm (1 in)
J	Handle Width (Horizontal Oval)	N/A	150 mm (6 in)
K	Separation Between Top of a Horizontal Oval and Underside of Handle	N/A	300 mm (12 in)
L	Separation Between the Deck and Bottom of a Horizontal Oval	N/A	300 mm (12 in)

3.8 SECONDARY MEANS OF ESCAPE AND EMERGENCY EGRESS

Emergency egress refers to the primary means of escape, under emergency conditions, from any level. This includes platforms or areas that are at a different elevation to the primary operating level of the facility or to grade. Generally, on elevated areas, stairs are required for the primary means of escape and secondary means of escape are deemed to be by ladder.

A secondary means of escape shall be provided for:

- all elevated work platforms serving fired equipment or three or more vessels;
- all elevated work platforms serving two or more pieces of equipment that are concurrently maintained and operated;
- work areas 760 mm (30 in) or more below operating level or grade that have an area of 20 m^2 (200 sq ft^2) or more;
- elevated work areas that have an area of 20 m^2 (200 ft^2) or more.

In elevated decks or platforms, the distance to the primary means of escape shall not exceed 25 m (82 ft) for accessibility and ease of escape in the event of an emergency.

The length of a dead-end platform, walkway or at the embarkation station (from the point of entry into the area) shall not exceed 6.1 m (20 ft).

Routing of escape ways shall be intuitive and clear of obstructions (i.e., equipment parts, instrumentation, instrument stands, pipe supports, valve hand-wheels, piping, etc.). Equipment shall not impinge on the required widths of routes designated as secondary means of escape/emergency egress.

On emergency egress or escape routes, all external doors shall always open outwards and in the direction of the escape route. Revolving doors and sliding doors shall not be used for emergency exits.

4. MANUAL HANDLING

4.1 GENERAL

The recommended weight limits assumes a single lift per 8 hours and optimum hand location, lift height, lift travel distance, and body position.

For any repetitive type lifting or non-optimal body positioning, the lift height, or distance, and other relevant handling factors will reduce the recommended maximal weights prescribed here.

Designers are directed to the project / regional HFE TA for specific guidance on preferred lifting arrangements (i.e., lifting height, reach to load, carrying posture etc), weights and load considerations (i.e., shape). This is also applicable where the anthropometric data associated with the local population deviates significantly from that associated with Northern European populations.

Provisions made for mobile hoisting equipment access (fixed or mobile) are subject to suitable material handling studies. Designers are directed to the project / regional HFE TA for input to appropriate materials handling studies to understand the task requirements and human factors issues associated with particular lifting arrangements, weight and load shape/size.

4.2 WEIGHTS AND LIFTING

The maximum weight to be lifted by one person using two hands, with the load close to the body, shall be 23 kg (50 lbs).

The maximum weight to be lifted by a two-person lift shall be 46 kg (100 lbs).

All removable or carried units should be provided with a handle or other suitable means for grasping, handling, and carrying. Items requiring handling should be provided with a minimum of two handles. Items weighing less than 4.5 kg (10 lb), whose form permits them to be handled easily, may be exempt from this requirement.

All loads that require manual handling shall be appropriately labelled to identify their weight, any specific lifting or handling requirements and an indication of the appropriate lifting points.

Lifting eyes shall be provided on all equipment to be lifted by mechanical lifting aids. These shall have a minimum of 100 mm (4 in.) of clear space around the eye. In the case of removable pipe spools or equipment that can be safely handled with straps/chains, no lifting eyes are required.

5. EQUIPMENT SPECIFIC REQUIREMENTS

5.1 GENERAL

In general, equipment shall be laid out such that:

- it causes a minimum of interference with movement of people or equipment around the site or tasks;
- it does not expose the operator to the risk of physical contact with equipment;
- it does not prevent reaching an egress point.

Sufficient space shall be provided around equipment (e.g., compressors, pumps, motors, heat exchanger bundles, valves, filters) for the lay down of heavy components during maintenance activities.

Large items that are difficult to remove should be so mounted that they will not prevent convenient access to other items. Smaller or more fragile items should be located so as not to be easily damaged during removal of the large items.

Check points, adjustment points, test points, cable, connectors, and labels shall be accessible and visible during maintenance.

Space shall be provided for the use of test equipment and other required tools without difficulty or hazard per the requirements contained in this specification.

Items most critical to system operation and which require rapid maintenance shall be most accessible. When relative criticality is not a factor, items requiring most frequent maintenance access should be most accessible.

High failure rate items should be accessible for replacement without moving non-failed items.

The workspace shall be designed to eliminate interference among workers during operation or maintenance. Multiple simultaneous tasks should be avoided unless the design has been specifically created to allow such tasks to be performed without workers interfering with each other.

Pull spaces provided for maintenance or repair of valves and other equipment (e.g., areas needed for the pulling of tube bundles from heat exchangers or condensers) shall be kept clear of all piping, cable trays, panels, and any other obstructions.

Guardrails restricting pull spaces shall be removable.

The pull space shall provide room for the personnel performing the tasks, tools required, lifting or support equipment, and transport devices (if used) to move the item from the area.

5.2 ROTATING EQUIPMENT

Adequate space based on the minimum worker envelope for standing, or squatting positions shall be provided around pump and compressor seals, couplings, bearings and stuffing boxes for removal and replacement activities as appropriate. The minimum clearance between pumps or pumps and piping shall at least be 1.2 m (48 in) for small pumps (< 18 kW) and 1.5 m to 2 m (60 in – 80 in) for larger pumps (taking base plates, valve hand wheels, pipelines, etc. into account).

Guards shall be provided around all exposed rotating equipment, as well as other dangerous situations (e.g., hot or cold surfaces, exposed electrical wiring, and crushing points). Removal of guards shall not be possible without special tools. Quick fasteners shall not be used.

Guards should be accessible from at least two sides (i.e., a guard over a rotating shaft should be accessible from either side of the shaft).

5.3 AIR COOLERS (FIN FANS)

The clear width of the header walkway shall be at least 750 mm (30 in).

Pipe-rack-mounted exchangers shall have drive assembly access platforms. Multiple bay exchanger banks mounted on a pipe rack shall have walkways that connect the drive assembly access platforms in each bay. Platforms and walkways shall be at the same elevation.

The drive assembly access platform on exchanger banks, mounted on a pipe rack, shall have an extension platform that permits lifting the motor with a crane. Maximum travel distance of the motor to the lift point shall be 33 m (108 ft.). Platform extensions shall be level.

5.4 HEAT EXCHANGERS

Adequate space shall be provided for heat exchanger tube bundle pulling activities. This shall include space for;

a) bundle pull space

b) walkway/ lay down area accessibility,

c) personnel performing the tasks,

d) tools required,

e) lifting or support equipment,

f) and transport devices (if used) to move the item from the area.

A minimum of 75 mm (3 in) space shall be provided for wrench room/access between pipe flanges and an exchanger shell or its insulation, and between a pipe or its insulation and the exchanger flanges.

Channel piping should be arranged with a removable section between the exchanger and block valves so that full access is available for bundle pulling and tube cleaning.

5.5 VERTICAL STORAGE TANKS (ABOVE GROUND)

Roof manways, equipment and instruments on top of vertical storage tanks (above ground), requiring personnel access, shall be located along the perimeter of the tank and accessible from an elevated work platform (permanent, mobile or scaffolding) to alleviate the need for walking on top these tanks where reasonably practical.

Where access on top the tank is required, the walkways and guardrails shall comply with the requirements contained in this document as well as in DEP 34.51.01.31-Gen., DEP 34.51.01.33-Gen. and the appropriate life-saving rules.

5.6 INSTRUMENT LOCATION

5.6.1 General

Indicating instruments, displays, including sight gauges, shall be located and designed so that they may be read to the degree of accuracy required by personnel in the normal operating or servicing positions without requiring the operator to assume an uncomfortable, awkward, or unsafe position. Display characteristics (e.g., clarity, legibility) shall allow displays to be viewed while wearing PPE, e.g., protective mask or goggles.

All monitored instruments required on elevated piping or non-accessible vessel components shall be tubed to the appropriate operational level or alternatively located on access platforms.

Whenever possible, indicating instruments shall be mounted at eye level, but in any case shall be at heights as specified in (3).

Indication instruments or displays requiring precise, frequent, or emergency reading, shall be at heights as specified in (3).

The viewing (reading) distance from the operator's eye to the face of the display or indicating instrument shall be based on the height of the letters, characters or markings on the display, not subtending less than 16 minutes (′) of arc at the operators eye.

Visual displays or indicating instruments shall be visually accessible from the normal work position without requiring the operator to stand on equipment components, handrails, wire ways/cable trays or their supports, pipes (bare or insulated), or any structure that is not specifically designed and provided for supporting a person's weight.

No display shall require the removal of a cover (for example, sheathing, deck plate) or any other component to be visible, unless the display is noncritical and a clearly marked quick access door is provided. The access door should be of transparent material.

Physical access or accessibility identifies the effort required for a person to reach devices such as an instrument, measuring element, instrument process connection, instrument utility connection, block valve or sampling point for the purpose of operational attention or regular maintenance. It includes the ability to reach such a device with all tools required to perform such operational attention or maintenance. In the context of this DEP and DEP 32.31.00.32-Gen., four accessibility levels are defined as follows:

5.6.2 Permanent accessibility

A device is considered permanently accessible, (1) if it is located not more than 460 mm (18 in) horizontally away from and at a height between 540 mm (21 in) and 1770 mm (70 in) vertically above grade, platform or walkway, and (2) if no obstructions are in place and (3) if such locations can be safely reached from those levels during operation or maintenance.

5.6.3 Limited accessibility

A device is considered to have limited accessibility, (1) if it is located not more than 1.0 m (39 in) horizontally away from and at a height between 1770 mm (70 in) and 4.0 m (13 ft) above grade, platform or walkway, and (2) if no obstructions are in place and (3) if operation or maintenance tasks can be performed in a safe manner from such a location by means of a mobile platform or ladder.

5.6.4 Poor accessibility

A device has a poor accessibility if it is located more than 4.0 m (13 ft), above grade platform or walkway, or at any other location that can only be safely reached during operation or maintenance by installing temporary facilities such as scaffolding or by using cranes or mobile man-lift platforms.

A device is also considered to have a poor accessibility if it can only be reached after removal or disassembly of other devices or components, such as thermal insulation or equipment noise hoods.

5.6.5 Inaccessibility

A device is considered inaccessible if it cannot be safely reached during plant or facility operation for the purpose of operational attention and maintenance.

Apart from the requirements for specific types of instruments as given in the relevant sections of DEP 32.31.00.32-Gen., field-mounted instruments shall be installed considering the following aspects:

- On-line instruments are to be mounted on or in the direct vicinity of the instrument process connection(s).
- The location shall ensure a representative measurement of the process condition.

Limited accessibility is acceptable for indicating instruments or displays, providing that they can be properly read from a permanently accessible location. The height of letters and numerals shall be determined by the required viewing (reading) distance and illumination levels above 10 Lux (1 foot-candle), unless otherwise identified in regulatory requirements which supersede this Specification. Designers are directed to the regional HFE TA for guidance on viewing distances and character heights.

Instruments shall not be subjected to excessive vibration (e.g., on suction or discharge lines of pumps or compressors, etc.) or to mechanical stresses, and shall not be exposed to temperatures that will influence the measurement or reliability of the instrument. Instruments shall not be mounted on vibrating pipe but instead mounted on the grade or a platform.

Heavy equipment such as control valves and inline flow meters of DN 100 (NPS 4) and larger, and all positive displacement meters and turbine meters, shall be accessible by mobile hoisting equipment. Where this is not possible, permanent-hoisting facilities shall be installed.

Instruments and their impulse lines shall be surrounded by sufficient free space to allow rodding-out of process connections and the removal of components such as:

a) bolts, nuts and gaskets etc;

b) covers and enclosures;

c) orifice plates from the orifice flanges;

d) removable parts from in-line flow meters;

e) internals from the control valve;

f) displacers from the displacer chambers;

g) thermometer elements from the thermowells.

h) ultrasonic acoustical transducers

i) special requirements for safe handling of toxic substances, as dictated by the relevant piping class.

Indicating instruments such as dial thermometers and pressure gauges that are attached directly to a pipe shall be mounted so they are read upright, or turned no more than 90° from the upright position if the upright orientation cannot be achieved.

Magnetic level gauges, gauge glasses and level transmitters shall be readable from grade, platforms, or permanent ladders.

Gauges and displays associated with frequently monitored systems shall be located outside acoustic enclosures wherever possible.

Instrument enclosures mounted inside the guardrail shall not interfere with access/egress. The choice of colour for characters shall be black characters on a white background rather than light characters on a dark background.

DEP 32.31.00.32-Gen., Appendix 3 provides the minimum accessibility requirements for plant or facility instruments.

NOTE: Irrespective of the minimum accessibility level given in Appendix 3 of DEP 32.31.00.32-Gen., access bility shall be specifically addressed during the 3D model reviews and optimized as reasonably practical and within reasonable cost. It may, for example, be feasible to relocate the piping take-off point during the engineering stage so as to change the accessibility level of a pressure transmitter from ‘limited’ to ‘permanent’ at no additional cost, or locating the thermowell so that it is access ble from the platform.

5.8 PIPING ACCESS AND CLEARANCES

The routing of pipe work shall not inhibit safe and rapid egress (i.e., impinge on required, unobstructed widths of walkway, manways, etc.) from structures in case of a leak, fire or other situation requiring personnel to rapidly evacuate an area.

On battery limit platforms when elevated, drain lines should be hard piped up to the location of the isolation valves on the platform. There should be an adequate number of drain hubs on the platform so that temporary lines do not congest the area causing tripping hazards and to accommodate the volume needed for draining without a spill. The drain hubs on the battery limit platform should be visible and readily accessible to prevent spills.

The minimum distance between a flange (with insulation) and a pipe or the insulation of a pipe in pipe tracks and trenches and on pipe racks shall be 30 mm (1.2 in). The minimum distance between a flange (without insulation) and a pipe or the insulation of a pipe in pipe tracks and trenches and on pipe racks shall be 75 mm (3 in) for tools access. The minimum distance between pipe flange (without insulation) and any equipment, columns or building wall shall be at least 75 mm (3 in). (See dimensions A or B in Figure 26).

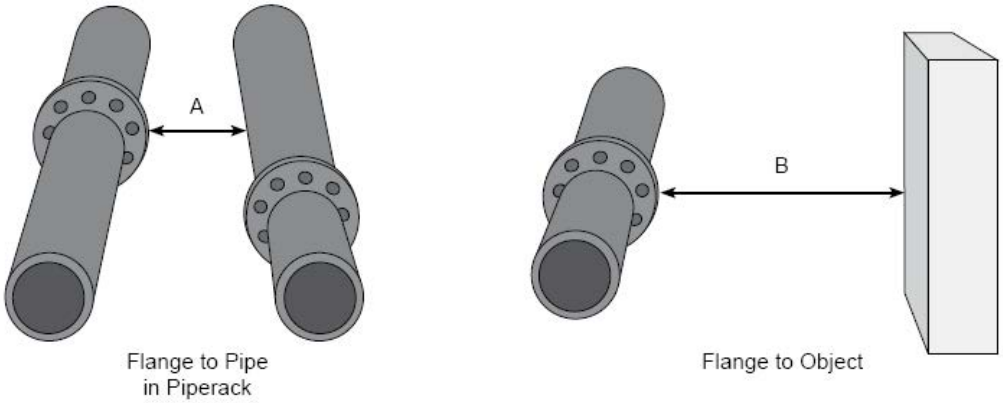


Figure 26 Pipe and flange clearances

The distance between the insulation of a low-temperature pipe and any other object shall be at least 100 mm (4 in) to allow for ice build up.

The distance between pipes shall allow for the turning of a spectacle blind, if present.

For pipe line size DN300 (NPS 12) and above, a min. of 460 mm (18 in) shall be provided as standing room between flange and any obstruction such as equipment, guard rail, etc. (see dimension B in Figure 26) for locations such as battery limit platforms, or where the flange joint is meant for operations (e.g., vessel isolation) or maintenance (e.g., removal of valves, etc.).

Due consideration shall be given to cold weather conditions which may lead to the requirement of additional clearances over and above the minimum horizontal clearance of 460 mm (18 in).

There shall be a minimum vertical clearance of 230 mm (9 in) between low point drains closure flange and soil, grade or platform. Due consideration shall be given to extreme snow and ice conditions which may lead to requirement of additional clearances over and above the minimum vertical clearance of 230 mm (9 in).

5.9 FLANGE HEIGHT

The space between a flange on a vertical pipe / vessel nozzles that penetrates decking shall be the length of the flange bolt plus 25 mm (1 in) (See dimension A on Figure 27 below). The same space requirement applies to a flange on a pipe that penetrates the ground or grating on an elevated work platform.

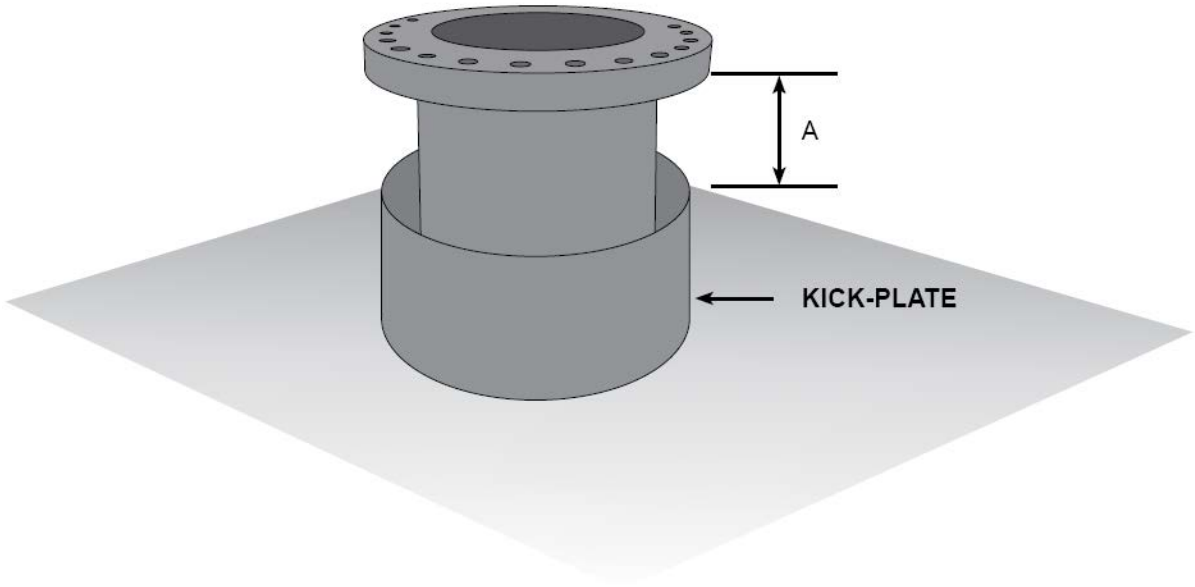


Figure 27 Flange height

5.10 DRAINS ON STAND-ALONE VESSELS

The hubs for draining stand-alone vessels shall be located at finished floor level in such a manner that an operator need move no more than 1500 mm (59 in) from a drain valve to the edge of a platform in order to see the drain hub. Drains from the elevated platform shall be hard piped to an open hub at grade. Multiple drain connections on a single platform may be piped to a common line. See Figure 28 below.

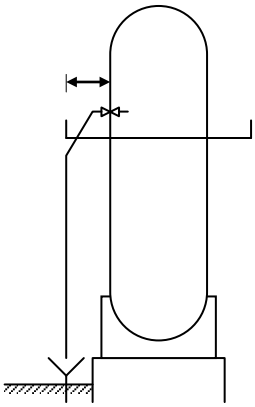


Figure 28 Drain hub for stand-alone vessel

5.11 VALVES (INCLUDING RELIEF VALVES)

NOTE: Detailed valve access and location requirements are identified in DEP 30.00.60.13-Gen.

Emergency shutdown (ESD) valves shall be accessible from grade or stairs and without exception shall be located in a clear area. Valve handles or wheels shall be located as per Category 1 valves.

No valves shall be located directly under a platform grating where it is necessary to remove the grating to operate the valve.

Platforms servicing valves shall be designed with all valve hand wheels located within the handrails.

Where safety valves have an associated isolation valve in close proximity, these isolation and relief valves shall be grouped together on a common platform accessible by stairs for inspection and servicing.

5.12 MANUAL SAMPLE POINT LOCATION

Manual sample points for volatile and/or toxic materials shall be close coupled to the process and should be located such that they are accessible from grade. If impractical, permanent access by stair may be acceptable.

Sample cabinets, when used, shall shield the operator from contact with the material being sampled. A 25 mm (1 in) hole at the top of the cabinet door with plug shall be provided to allow the interior air to be gas tested prior to opening cabinet door.

The cabinet door shall be provided with view panel to see sample bottles/bombs being filled. The see-through panel should be a plexi-glass type material.

The sample cabinet shall be labelled and capable of being opened without requiring any tools or the removal of any securing fasteners or other devices.

Top of sampling cabinet shall be no higher than 1900 mm (74 in) and the bottom no lower than 760 mm (30 in).

Sample cabinets shall be heated where appropriate depending on ambient environmental conditions (cold weather).

Volatile and/or toxic substances shall be prevented from escaping into the local atmosphere by a venturi device and vented to a safe location.

All connections for gas bombs shall be located inside the cabinet. Connections for liquid lines may be located outside the cabinet but must be close coupled in climates subject to freezing.

The last sampling valve at the sampling point shall be located outside the cabinet but such that the operator can visually observe the sample being collected.

The minimum standing worker envelope shall be provided around sampling points to allow operator to perform sampling tasks while using appropriate personal protective equipment such as gloves and respirators.

The sample bottles and bombs shall be properly secured in place when located inside a cabinet during sampling. Lighting should be provided inside the cabinet and a minimum clearance of 50 mm (2 in) shall be provided around the circumference of the sampling bomb when connected to allow adequate room to grip the bomb while wearing gloves.

5.13 GUARDRAILS

For projects that have to comply with European regulatory requirements, guardrails shall be installed along all the edges of open sided decks, floors, walkways, platforms, runways, and balconies at all locations 500 mm (20 in) or greater above finished floor level. Similarly, on stairs, steps or stiles a guardrail shall be fitted whenever the height to climb exceeds 500 mm (20 in).

For USA this dimension shall be 610 mm (24 in). For other regions the Principal shall specify the appropriate dimension.

Guardrails shall be installed along rooftop service platforms edges that are less than 1500 mm (59 in) from the roof edge.

Walkways and platforms not provided with guardrails (less than 500 mm (24 in)) shall have a guard at least as wide as the walkway at any sharp change of direction (L or T-shaped).

Floor or deck openings 100 mm (4 in) x 100 mm (4 in) or greater, which are left exposed and unattended, require covering, guard railings or barriers.

Regardless of height, open-sided floors, walkways, platforms, or runways above or adjacent to dangerous equipment, valves, piping or other hazards, shall be guarded with a standard guardrail.

5.14 STORED ENERGY DEVICES

Devices that operate under stored energy (e.g., springs under compression, coiled tubing, shock absorbers operated by pneumatic pressure, and pressurized bottles) shall be designed so the energy can be safely released or constrained before any maintenance tasks are performed. The means of release or constraint shall be immediately apparent to the maintainer and shall be designed so that the means cannot be inadvertently activated once it has been deactivated.

All stored energy devices shall be labelled as such and shall have a DANGER hazard warning sign attached to the device. Procedures for releasing or constraining the energy shall be displayed on the unit.

5.15 EQUIPMENT OR PIPING WITH HOT OR COLD SURFACES

Equipment that, in normal operations, exposes personnel to surface temperatures greater or less than those shown in Table 25 for momentary contact and accessible from normal working areas and access ways shall be provided with personnel protection to a height of 2000 mm (80 in) above the walking level. Surface temperatures induced by climatic environment are exempt from this requirement. Cryogenic systems shall also be guarded.

Table 25 Thermal temperature limits[2]

Exposure Type	**°F** (°C)	
	Lower Limit	Upper Limit
Momentary Contact	**32°** (0°) and below	**150°** (65°) and above
Prolonged Contact or Handling[1]	**32°** (0°) and below	**120°** (49°) and above

NOTES: 1) Hot or cold surfaces in machinery rooms or other locations, where a person could fall into or lean on, are considered a prolonged contact condition.

2) Contact with surfaces at this temperature can cause severe pain and tissue damage.

5.16 LUBRICATION

Configuration of equipment containing mechanical items requiring lubrication shall permit both lubrication and checking of lubricant levels without disassembly. All lubricant fittings shall be directly accessible and should not require tubing to connect the fitting to its lubricated source. Permanently lubricated items for which lubricant lasts for the life of the items are excluded.

A lubrication chart should be a permanent construction, mounted at or near the lube port or at the operator station of the equipment.

All lubrication storage or service tanks shall be labelled to identify the type of lubricant and the capacity of the tank. The label shall be seen from the filling position.

Where incorrect filling of a lubrication tank is possible (e.g., a lube oil tank could mistakenly be filled with fuel oil), the tanks shall be designed in such a manner as to make it physically impossible for a person to put the wrong material in the wrong tank.

6. REFERENCES

In this DEP, reference is made to the following publications:

NOTES:
1. Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments/supplements/revisions thereto.
2. The DEPs and most referenced external standards are available to Shell staff on the SWW (Shell Wide Web) at http://sww.shell.com/standards/.

SHELL STANDARDS

DEP feedback form	DEP 00.00.05.80-Gen.
Human Factors Engineering – Valves	DEP 30.00.60.13-Gen.
Human Factors Engineering – Design for process safety critical tasks	DEP 30.00.60.19-Gen.
Instruments for measurement and control	DEP 32.31.00.32-Gen.
Structural design and engineering of onshore structures	DEP 34.00.01.30-Gen.
Onshore ancillary steel structures	DEP 34.28.00.33-Gen.
Vertical steel storage tanks – Selection, design and construction (amendments/supplements to EN14015)	DEP 34.51.01.31-Gen.
Aboveground vertical storage tanks (amendments/supplements to API Standard 650)	DEP 34.51.01.33-Gen.
Structural steel design of small deepwater offshore skids, facility packages, and subsea sleds and manifolds (based on AISC Steel Construction Manual ASD, API RP 2A-WSD and AWS D1.1)	DEP 37.81.10.31-Gen.

INTERNATIONAL STANDARDS

Ergonomic principles in the design of work systems	ISO 6385

7. FIGURES

8. TABLES