DEP SPECIFICATION

HUMAN FACTORS ENGINEERING - VALVES

DEP 30.00.60.13-Gen.

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DESIGN AND ENGINEERING PRACTICE

PREFACE

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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for applying Human Factors Engineering (HFE) principles to the design and layout of valves for both onshore and offshore facilities and equipment. It includes the following:

- A procedure for analysing and then classifying the criticality of valves for a specific application;
- Guidance on selection of the appropriate type of valve operator/actuator;
- HFE design requirements for the location and orientation of manual valves.

This DEP applies to new facilities and modifications to existing facilities; it is not intended to apply to existing facilities that are not being modified.

Accessibility requirements of instruments and their associated valves are addressed in DEP 30.00.60.20-Gen. and DEP 32.31.00.32-Gen.

This is a revision of the DEP of the same number dated April 2009; 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 authorized 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 for other similar facilities.

When DEPs are applied, a Management of Change (MOC) process should 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 may 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 regard 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
ALARP	As Low As Reasonably Practicable. As defined in HSSE & SP CF Glossary - the point at which the cost (in time, money and effort) of further risk reduction is grossly disproportionate to the risk reduction achieved.
HSSE CF	Shell Group HSSE Control Framework
HEMP	Hazards and Effects Management Process
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 optimize human and system performance. [ISO 6385]
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.
Ops	Operations
ORM	Shell Group Opportunity Realisation Manual.

1.3.3 Abbreviations

Term	Definition
BDEP	Basic Design and Engineering Package
EPC	Engineering, Procurement and Construction
HFE	Human Factors Engineering
HSSE & SP	Health, Security, Safety, Environment and Social Performance
MAS	Marine Advisory System
MOV	Motor Operated Valve
ORM	Opportunity Realisation Manual
PEFS	Process Engineering Flow Scheme
P&ID	Piping and Instrumentation Diagram
RVO	Remote Valve Operator
TA	Technical Authority
VCA	Valve Criticality Analysis

1.4 CROSS REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets ( ). Other documents referenced by this DEP are listed in (5).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated April 2009. In addition to separating the content in the previous version that was background and explanation into the companion Informative document, some minor editorial changes were made.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be sent to the Administrator at standards@shell.com, using the DEP Feedback Form. The DEP Feedback Form can be found on the main page of "DEPs on the Web", available through the Global Technical Standards web portal http://sww.shell.com/standards and on the main page of the DEPs DVD-ROM.

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 BACKGROUND AND GENERAL REQUIREMENTS

2.1 BACKGROUND

This is one of a series of DEPs that support the implementation of Human Factors Engineering on projects. The design requirements (4) with regard to valve location and orientation are mainly applicable to manual valves. However, they also apply to motorised, mobile actuator or otherwise remotely operated valves which could need rapid or frequent manual intervention to override and manually operate them, or where visually checking their status forms part of an HSSE critical activity.

Accessibility requirements of instruments and their associated valves are addressed in DEP 30.00.60.20-Gen. and DEP 32.31.00.32-Gen.

2.2 APPLICATION OF HFE PRINCIPLES IN DESIGN AND ENGINEERING

HFE is the process of integrating human capabilities, limitations, requirements and expectations in the design of products, workplaces or work systems (plant/facility) resulting in the effective, efficient, safe and healthy functioning of human beings.

The aim is to improve the efficiency of operational and maintenance task performance, to protect operators from short or long-term health impairments, and to minimise the likelihood of human error contributing to process safety or loss of production.

2.3 GENERAL HFE PRINCIPLES RELATING TO VALVE SELECTION AND LAYOUT

Valves (including those on Vendor supplied skid-packaged units) shall be selected, located and labelled, based on a Valve Criticality Analysis (VCA) so that they can be identified, operated, maintained and inspected:

- with accessibility and visibility appropriate to their service;
- without exposing operators to risk of injury or exposure to hazards.

Selection of valves shall take adequate account of the ability of the expected workforce to apply and sustain the force needed to operate them. This shall include consideration of the physical size and strength, as well as gender of the workforce.

- In general, valves should be selected that have been designed in such a way as to facilitate ease of operation and maintenance. (For example, valve handles that incorporate knurling and other types of grip have been shown scientifically to support ease of operation.)

Actuated valves should be used where the frequency of operating them, the valve characteristics, and the layout or work environment around the valve are such that either:

- the human operators will be exposed to unacceptable risk of musculo-skeletal injury; or
- unavoidable constraints on accessibility could mean that operators have difficulty ensuring that valves in critical service are properly open or closed.

3 VALVE CRITICALITY ANALYSIS

A Valve Criticality Analysis (VCA) shall be conducted during the early DEFINE phase, when the PEFS (P&IDs) first become available. This ensures that:

- the results can be factored into valve procurement and piping and layout design;
- space for physical access and other design requirements needed to identify, operate, maintain and inspect valves can be integrated into layout drawings and 3D models.

VCA session results shall be appropriately documented. The initial classification of valves and selection of appropriate actuators may need to be reviewed and revised when more detailed information becomes available at a later stage in the design or implementation of a project.

The associated access and location requirements for each valve type and HFE design criteria presented in (4) shall be included in the appropriate project specifications and contractual documentation. Deviations shall require the approval of Operations and the HFE TA.

Criticality ratings of valves shall be included on PEFS (P&IDs), and if a 3D CAD model is being used for design, Category 1 valves shall be coded therein (e.g. by colour coding 3D shapes).

Compliance shall be validated throughout the EXECUTE (Engineering, Procurement and Construction) Phase of the project and during pre-start-up audits.

3.1 VALVE CRITICALITY RATING

3.1.1 General

Valves shall be rated by criticality. The following three categories are recommended. These criteria shall be reviewed and agreed upon prior to starting the analysis. The final criteria shall balance ease of access for operations against maintenance access and project costs. Risks to health and safety, including risk of human error, shall be kept as low as reasonably practical.

3.1.2 Category 1 (C-1) valves

Category 1 (C-1) valves include those essential to normal or emergency operations where rapid and unencumbered access is essential. The height, reach distances and visibility shall conform to the “preferred” location as outlined in (4).

These are valves that meet any or all of the following criteria:

a) Valves essential to production;

b) Valves essential to process safety or asset integrity;

c) Particularly large valves;

d) MOVs with high failure rates and which require rapid corrective action;

e) Valves being used in a service or under operating conditions where the failure rates are not known or may be unreliable.

f) Valves where consequence of failure to obtain quick access would be serious (e.g. process shutdown and/or damage to facilities or personnel);

g) Valves for which the expected routine operation, inspection and/or maintenance is more frequent than once every 6 months.

3.1.3 Category 2 (C-2) valves

Category 2 (C-2) valves are those that are not critical for normal or emergency operations but are used during routine inspection or maintenance activities.

These are valves that meet any or all of the following criteria:

- Valves associated with equipment for which rapid intervention is unlikely to be needed.
- Valves with a low operating or inspection frequency (i.e. less than once every 6 months).

3.1.4 Category 3 (C-3) valves

Category 3 valves are normally non-operating valves that are used or inspected in particular circumstances on an infrequent or rare basis (e.g. hot tap valves, hydrostatic test vent, high point vent or low point drain valves located in pipe rack) and are not used in HSSE critical activities.

4 HFE DESIGN REQUIREMENTS FOR THE SELECTION, LOCATION AND ORIENTATION OF VALVE OPERATORS/ACTUATORS

4.1 VALVE CRITICALITY

4.1.1 Category 1 valves (C-1)

Permanent accessibility shall be provided at deck or ground level or via a permanent standing elevated surface. If such access at ground or deck level is not practical, access by stairs to the elevated platform is acceptable.

Valve identification and status shall be clearly visible to an approachable operator position i.e., on an adjacent walkway, access platform, or in space around equipment that is intended for human access.

4.1.2 Category 2 Valves (C-2)

Height and reach distance and visibility of C-2 valves should be the same as for Category 1 valves i.e., “preferred” location as outlined in (4). Category 2 valves may be located within the “acceptable area” as outlined in (4), depending on their size and the force needed to operate them.

Where ground level access, or where deck level access by stairs, is not justifiable, a vertical fixed ladder plus a small standing surface shall be provided for access to C-2 valves.

The use of auxiliary equipment to gain access (e.g. mobile platforms, man lift, or scaffolding) for maintenance purposes may be acceptable as long as it is indicated and allowed for in the design by preserving sufficient space and access for personnel, tools, parts, and equipment.

Identifying and inspecting the status of C-2 valves may require the operator to enter space not intended for human access, or to temporarily adopt an awkward posture provided doing so does not induce human error or put the operator at risk of injury or exposure to hazards.

4.1.3 Category 3 valves (C-3)

Permanent accessibility to and visibility of C-3 valves is desirable but not essential. No specific location requirements are imposed.

The use of auxiliary equipment to gain access (e.g. mobile platforms, personnel lift, and/or scaffolding) to C-3 valves shall be indicated and allowed for in the design.

Portable ladders should not be used for accessing C-3 valves. Any proposed exception(s) to this shall be subject to specific review and approval.

Height and reach distances to C-3 valves when operated from auxiliary equipment shall conform to the “preferred” location as outlined in (4).

4.2 VALVE OPERATOR/ACTUATOR

4.2.1 Maximum cracking force

The maximum force required to initially crack open a valve with a handwheel or lever of more than 125 mm (5 in) in diameter or length shall not exceed 445 N (100 lbf), as measured on the rim of the handwheel or the end of the lever or wrench. This force limit is applicable to valves located within the “preferred” location as depicted in Figures 4.1 and 4.2.

For handwheels or levers between 50 mm (2 in) and 125 mm (5 in) in diameter or length (i.e. intended for one-handed operation) the maximum force shall not exceed 66 N (15 lbf), as measured on the rim of the handwheel or end of lever or wrench. This force limit is applicable to valves located within the “acceptable” and “preferred” locations as depicted in Figures 4.1 and 4.2.

These force limits do not apply to valves located outside the “preferred” and acceptable” regions depicted in Figures 4.1 and 4.2. Human operators are not able to safely and reliably exert the specified maximum forces outside those regions. Similarly, these force limits may not apply to all populations worldwide. They may need to be validated and amended by a regional HFE TA.

Valves should be designed and located so as not to require portable extensions for access or leverage. Engineered valve wrenches may only be used if the wrench has been specifically designed for the valve to be operated.

4.2.2 Sustained force

The sustained force to operate a handwheel or lever (i.e. once the valve has been "cracked") shall not exceed 147 N (33 lbf) for valves with handwheels or levers above 125 mm (5 in) in diameter or length.

4.2.3 Number of rotations

Any valve that requires more than 100 turns to go from fully open to fully closed should be equipped with motorized (hydraulic, electric or pneumatic) or mobile operators depending upon the additional considerations in (4.2.4) and (4.2.8).

For applications where a valve may be rotated rapidly through several revolutions, a spinner handle may be provided. Such handles shall not be used, however, if the projecting handle is vulnerable to inadvertent movement from a critical wheel setting or if the rapid rotation creates a safety hazard.

4.2.4 Additional considerations for selecting MOVs or mobile operators/actuators

The following additional factors shall be considered when selecting the type of operator/actuator:

a) In general MOVs or mobile operators/actuators shall be considered for Category 1 (C-1) valves including process control valves (e.g. flow control, emergency isolation valves, emergency shutdown valves, etc.). They should only be considered for categories 2 and 3 (C-2 and C-3) in exceptional cases;

b) Type of service (crude, steam, water etc.);

c) Remoteness of valve (considering travel time);

d) Available staffing;

e) Valve size;

f) Access available;

g) Operating environment (e.g., hazardous area or during upset condition);

h) Extreme climate (heat or cold);

i) Frequency of use, (i.e. more than once every 6 months);

j) Unreliability of infrequently used MOVs (typically MOVs are unreliable if not used on a regular basis);

k) Number of valves to be operated by same operator or group of operators (e.g., blending valves, switching reactors etc.), considering workload and potential time constraints.

4.2.5 Gear operators

If a valve is not a MOV, or is not provided with a mobile operator/actuator or any type of actuator to assist the operator, and if it requires forces greater than those stated in (4.2.1) and (4.2.2), then it shall be provided with a gear-operated handwheel.

Table 4.1 gives examples of valves that will usually fall in this category.

Table 4.1 Examples of valves requiring gear operators (if not MOVs or otherwise assisted)

ASME Class	Valve Type			
	Gate	Globe	Ball	Butterfly
150	DN 350 (NPS 14) and larger	DN 250 (NPS 10) and larger	DN 150 (NPS 6) and larger	DN 200 (NPS 8) and larger
300	DN 300 (NPS 12) and larger	DN 200 (NPS 8) and larger	DN 100 (NPS 4) and larger	DN 200 (NPS 8) and larger
600	DN 150 (NPS 6) and larger	DN 200 (NPS 8) and larger	DN 100 (NPS 4) and larger	
900	DN 100 (NPS 4) and larger	DN 150 (NPS 6) and larger	DN 80 (NPS 3) and larger	
1500	DN 100 (NPS 4) and larger	DN 80 (NPS 3) and larger	DN 80 (NPS 3) and larger	
2500	DN 80 (NPS 3) and larger	DN 80 (NPS 3) and larger	DN 80 (NPS 3) and larger	

NOTES:
1. The above are examples for guidance purposes. Valve torques can vary for different manufacturers and shall be checked to ensure appropriate selection of gear operators based on the maximum and sustained force requirements provided in (4.2.1) and (4.2.2).
2. Some Manufacturers provide gear operators with their standard offer.

4.2.6 Chain operators

Chain-operated valves shall not be used unless approved by the Principal in consultation with an HFE TA.

4.2.7 Remote valve operators

Remote valve operators (RVO) or mechanical extenders, rather than chain operators, should be used to:

- operate valves that cannot be located within the reach limit distances given in (4.3);
- where permanent access platforms will restrict maintenance access;
- in hazardous areas (confined space, below water or where noxious fugitive emissions may be present).

4.2.8 Mobile operators

The use of appropriate mobile operators (e.g. air drill or nut runner) may be considered for gear operated valves requiring a large number (> 100) of turns, provided the following additional requirements are adhered to:

- Mobile operator shall be matched with valve type to ensure no damage to valve operation.
- Mounting point shall be accessible from a suitable (preferably permanent) standing surface and have a stop or bracing point to absorb the reaction torque of the mobile operator.
- To protect the operator of the mobile operator, a torque reaction bar and/or a suitable mounting bracket shall be used at all times.
- Size, weight and portability of mobile operators shall comply with the appropriate HFE requirements for lifting and hoisting (consult a regional HFE TA for more details).

4.2.9 Manual valves

Manual valves shall be operated by means of a circular handwheel or lever.

Handwheels and levers on all valves shall conform to the operational stereotype of requiring to be turned in an anticlockwise direction for opening and a clockwise direction for closing.

Valve handwheels should not be larger than 455 mm (18 in) in diameter. Larger handwheels may apply more torque but due to their size, make less efficient use of the human strength and will also require more space to operate.

Handwheels shall be designed with knurling, indentation, high-friction covering, or a combination of these to facilitate the operator's grip for applying maximum torque.

Valve lever handles shall be as long as necessary to produce the necessary torque to crack open and turn the valve but without exceeding the maximum cracking force. Handle lengths normally range from 355 mm (14 in) to 915 mm (36 in) in length.

Valve lever handles may be of any shape (circular is preferred) but should have a circular grasping surface for the final 180 mm (7 in) of their length. The grasping surface should be between 13 mm (0.5 in) and 25 mm (1 in) in diameter and should have a non-slip surface.

4.3 VALVE LOCATION

4.3.1 Access

Valves shall be located so that the operator is provided with a safe and easy access for identification, operation, inspection, readings and maintenance. Valves shall not be accessed by standing on, or with the aid of, adjacent pipe-work, insulation, pipe-racks, cable trays, handrails, or any other equipment or object.

The minimum distance between any obstruction and handwheel/valve stem stipulated in Figure 4.1 is for valve operation only and does not include workspace needed for maintenance.

Valve stems shall be checked in both their closed and open position when assessing clearance envelopes for operation and ensuring that stems do not constitute a potential obstruction hazard to operators (e.g. protruding into an escape route or walkway).

A minimum of 75 mm (3 in) clearance shall be provided between the outside rim of a valve handwheel or the end of a valve handle and any obstacle located within the field of travel of the handwheel or handle. For valves installed in cold weather environments, the minimum clearance provided shall be increased to 125 mm (5 in).

Drain valves shall be located outside vessel skirts.

4.3.2 Position indicators

Valves equipped with valve position indicators shall be installed so that the indicator’s status is directly visible from a normal vantage point (e.g. adjacent to walkway) when opening or closing the valve. For valves fitted for remote control, an independent indicator showing whether the valve is open or closed shall be provided on or adjacent to the control that is visible from the operator’s normal standing position.

4.3.3 Mounting heights

4.3.3.1 Handwheel operated valves

Valve handwheels shall be mounted in the “preferred” or “acceptable” vertical and horizontal locations as shown in Figures 4.1 and 4.2, depending on valve stem orientation and maximum force requirements as stated in (4.2.1) and (4.2.2). See notes and exceptions to these dimensions at the bottom of the figures.

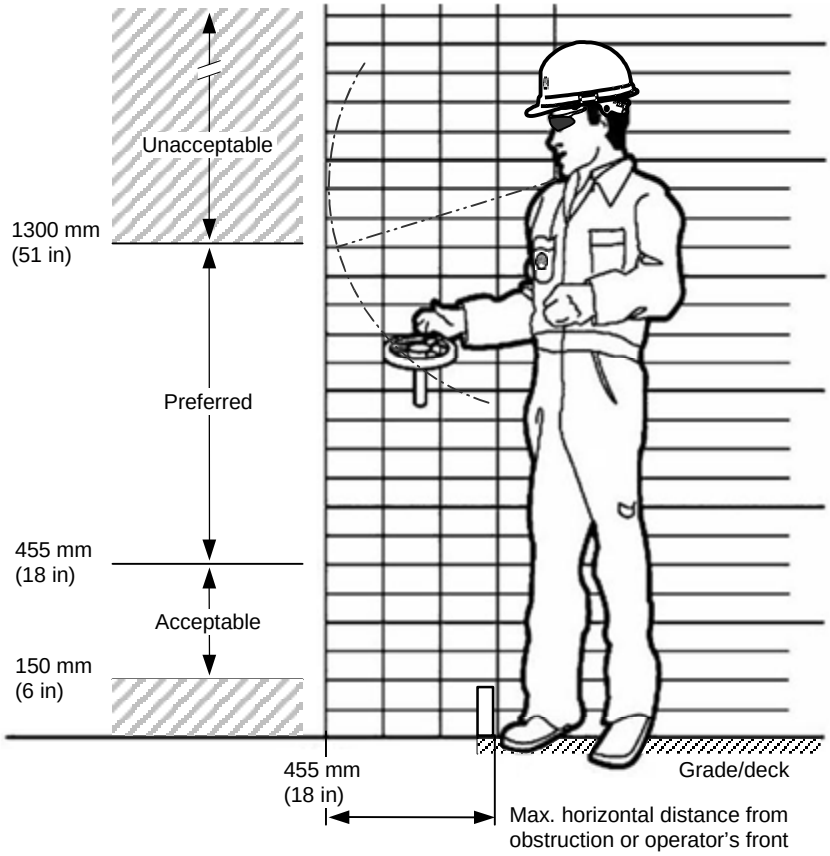

Figure 4.1 Mounting heights for hand-wheel operated valves with vertical stems

NOTES:

1. Distances or heights are measured to handwheel centreline. For gear-operated valves with a handwheel provided with a spinner handle, maximum horizontal distance is measured to the edge of the handwheel furthest from the operator.
2. Heights are to be to the maximum extension of valve stem for rising stem valves.
3. These dimensions are appropriate male and female personnel worldwide from 5th to 95th percentile, except that the top limit for the "Preferred" choice location should be reduced by 100 mm (4 in) to accommodate male and female populations in regions such as West Africa, Southeast Asia, Southern China, parts of Latin America, India and Japan.
4. For valves located below 455 mm (18 in), sufficient clearance of at least 910 mm (36 in.) should be provided behind the operator to accommodate a squatting posture.

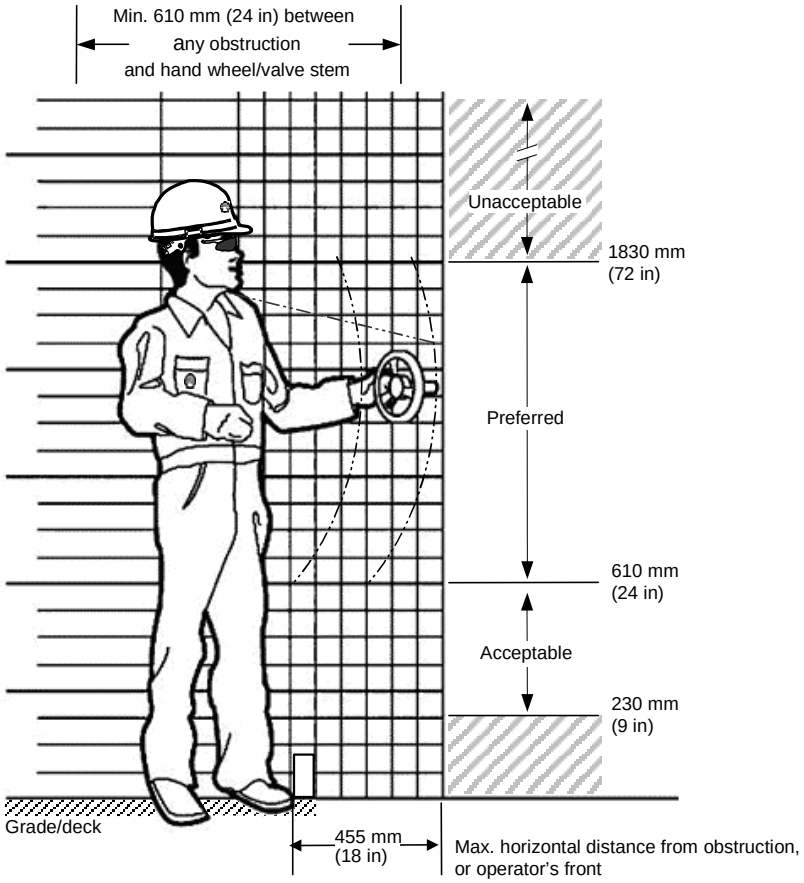

Figure 4.2 Mounting heights for handwheel operated valves with horizontal stems

NOTES:
1. Distances or heights are measured to handwheel centreline. For gear-operated valves with a handwheel provided with a spinner handle, maximum horizontal distance is measured to the edge of the handwheel furthest from the operator.
2. These dimensions are appropriate for personnel worldwide, from the 5th percentile of the female population to the 95th percentile of the male population, except that the top limit should be set at 1755 mm (69 in) for 5th percentile males and 66 in (1675 mm) for 5th percentile females in regions such as West Africa, Southeast Asia, Southern China, parts of Latin America, India and Japan.
3. For valves located below 455 mm (18 in), sufficient clearance of at least 910 mm (36 in.) should be provided behind the operator to accommodate a squatting posture.

4.3.3.2 Lever operated valves

Valve levers shall be mounted in the locations as shown in Figures 4.3 and 4.4, depending on valve stem orientation and maximum force requirements (4.2.1). No valve handles shall protrude into walkways or work areas when the valve is in the closed position.

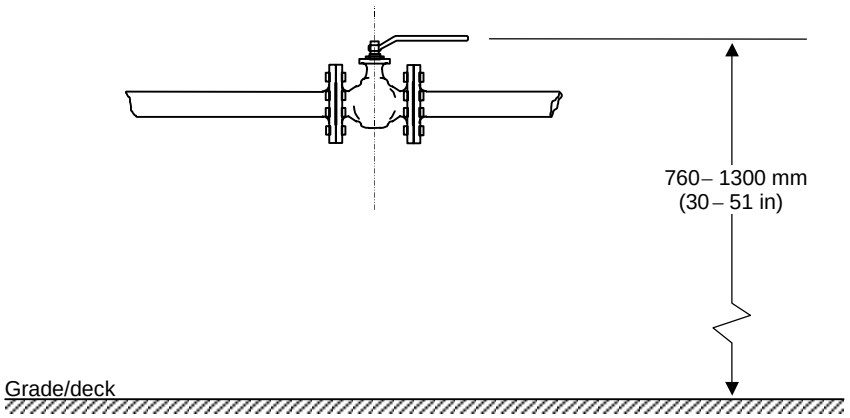

Figure 4.3 Mounting heights for lever-operated valves with vertical stems

NOTE: These dimensions are appropriate for personnel worldwide, from the 5th percentile of the female population to the 95th percentile of the male population, except that the top limit should be reduced to 1145 mm (45 in) to accommodate 5th percentile females in regions such as West Africa, Southeast Asia, Southern China, parts of Latin America, India and Japan.

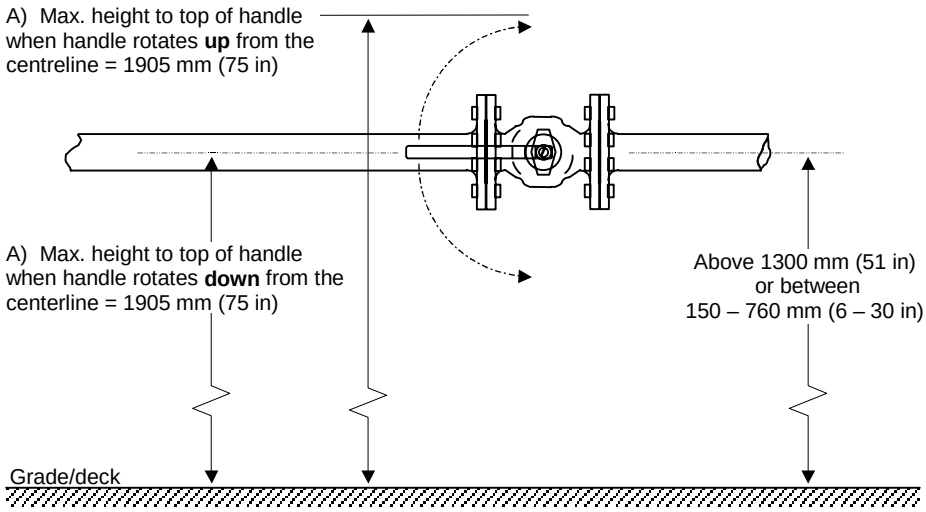

Figure 4.4 Mounting heights for lever-operated valves with horizontal stems

NOTE: These dimensions are drawn for North American males, and are therefore appropriate for other regions such as Northern Europe, Australia, UK, and Central Europe. These dimensions should be reduced to 1805 mm (71 in) for 5th percentile males in areas such as West Africa, Southeast Asia, Southern China, parts of Latin America, India and Japan, and 1725 mm (68 in) for 5th percentile females in West Africa, Southeast Asia, Southern China, parts of Latin America, India and Japan. To accommodate the same international population of 5th percentile females, horizontal stem valves should be located at least 1145 mm (45 in) above the standing surface, rather than 1300 mm (51 in) as shown.

Valves oriented with the stem in a horizontal position are preferred when the lever is located between 150 mm and 760 mm (6 in and 30 in), or more than 1300 mm (51 in) above the deck as shown in Figure 4.4. However, the maximum height above the deck to the valve tip should not exceed 1905 mm (75 in). The valve handle is not permitted to rotate down from centreline if there is a walking surface directly underneath.

Valves in a vertical section of the pipe e.g., located in a manifold or at battery limit, shall be oriented with all the stems on the same side as shown in Figures 4.5 and 4.6, with a 75 mm (3 in) clearance maintained between the lever and any obstruction.

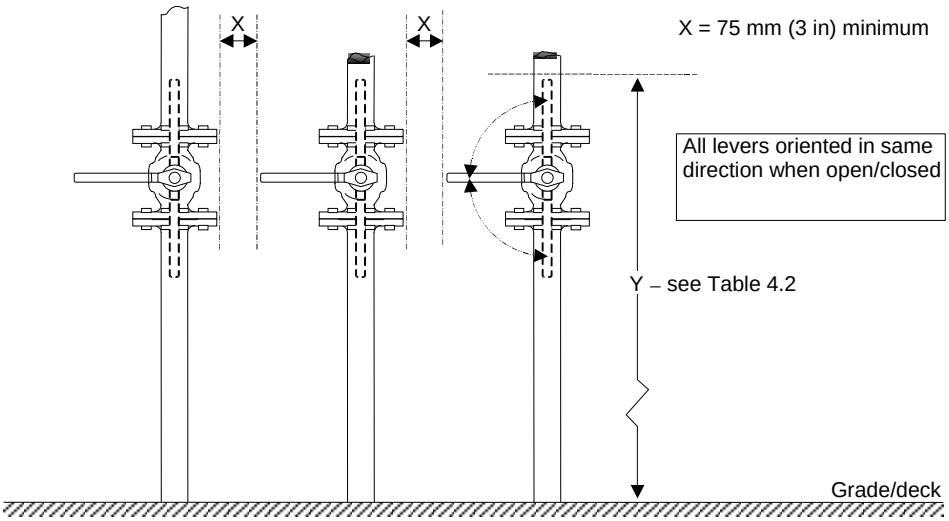

Figure 4.5 Manifold or battery limit valves with 75 mm (3 in) minimum gap between lever-end and the nearest flange/obstruction

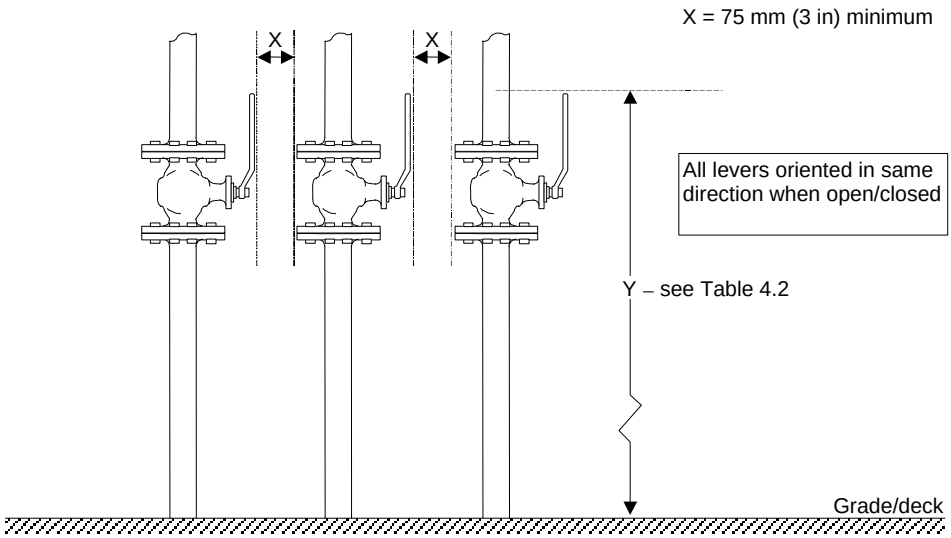

Figure 4.6 Manifold or battery limit valves with 75 mm (3 in) minimum gap between front face of lever's outer surface and nearest flange/obstruction

NOTE: DEP 31.38.01.11-Gen., Section 3.8 requires that valves and flanges shall be staggered whenever possible to ease operation and reduce space. This is acceptable as long as the minimum clearance is maintained and valve heights comply with requirements of Table 4.2.

Table 4.2 Height of valve lever end above grade/deck

	Height (Y) of valve lever end above grade/deck
Preferred	610 mm to 1905 mm (24 in to 75 in)
Acceptable	230 mm to 610 mm (9 in to 24 in)
Unacceptable	< 230 mm or > 1905 mm (< 9 in or > 75 in)

4.3.3.3 Valves operated from vertical ladders

Category 1 (C-1) valves shall not be located so that they have to be operated from a ladder (caged or uncaged)

Other valves should not be located so that they have to be operated from a ladder, but if this is unavoidable the following requirements shall apply:

- The handwheel or lever shall be located between 150 mm (6 in) and 610 mm (24 in) from the edge of the ladder stringer in order to open and close the valves, as shown in Figures 4.7 and 4.8;
- Valve location, orientation, and actuator type shall be selected to enable opening or closing with one-hand only.

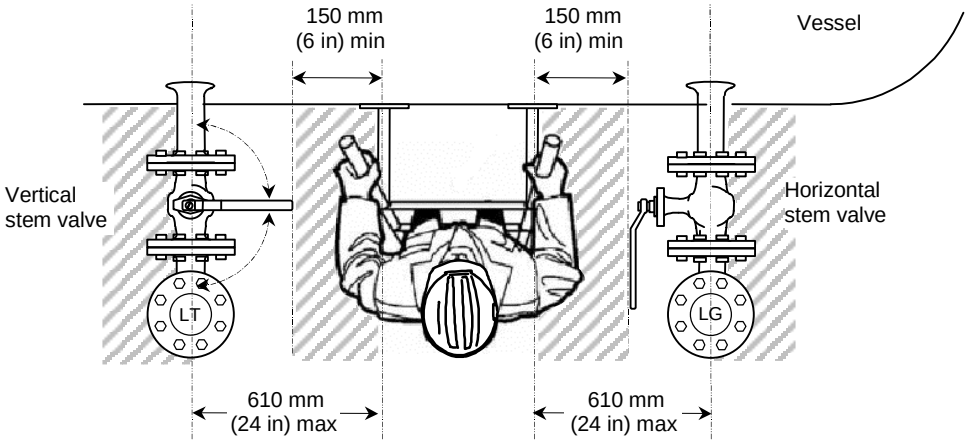

Figure 4.7 Required lateral reach distances (minimum and maximum) for level instruments, gauge nozzles or valves on the side of a vessel; lever/handle operated

4.3.4 Valve maintenance considerations

4.3.4.1 Access

The minimum distance between valve flanges and any obstruction shall be the bolt length plus 25 mm (1 in) to allow access for hand tools and torquing of bolts.

Where standing room is required for maintenance access to valve flanges, the clearance between a flange and a wall, structural steel, or guardrail shall not be less than 460 mm (18 in).

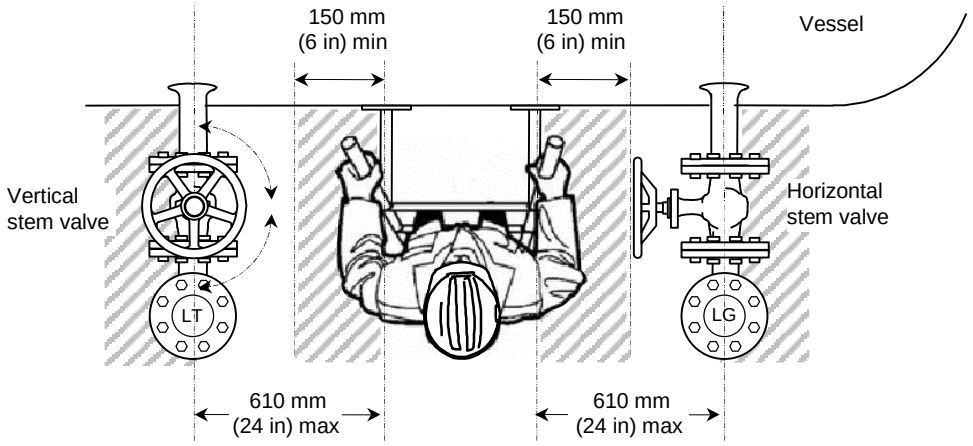

Figure 4.8 Required lateral reach distances (minimum and maximum) for level instruments, gauge nozzles or valves on the side of a vessel; hand-wheel operated.

4.3.4.2 Valve mass and lifting aids

Valves with a mass less than 23 kg (50 lb) shall be located so that they can be lifted by one person without risking injury through poor lifting posture. Valves with a mass between 23 kg (50 lb) and 46 kg (100 lb) shall be located so that they can be lifted by two persons, provided the valve can be lifted without having to reach over or around items between the persons and the valve.

NOTE: The 23 kg (50 lb) limit is the lifting equation load constant in NIOSH 94-110. The recommended mass limit assumes a single lift and optimum lift-height, lift-distance and body position. For any repetitive type lifting or non-optimal body positioning, the lift height or distance, and other relevant handling factors, a regional HFE TA shall be consulted.

For all valves in excess of the above weight limits and lifting heights that must be lifted for repair, replacement or maintenance, permanent or portable assisted lifting devices (e.g. ‘chain-falls’, ‘lever chain puller/hoist’) shall be provided to aid the lifting or moving. If such devices are provided, space for them and the personnel, who use and manoeuvre them, shall be provided.

Assisted lifting devices provided to assist in lifting or moving equipment should be able to be located (e.g. by means of pad eyes or beam clamps) directly over the item to be lifted so the lift is vertical to prevent swinging loads when the items are raised or lowered. Two lifting aids may be used simultaneously; one on each side of the valve, if a vertical lift is not feasible.

Hoisting areas should be free of obstacles such as cable trays, HVAC ducting, structural components, piping, and other equipment within a radius of at least 305 mm (12 in) at the point of hookup to the device.

There shall be sufficient clearance above each valve to attach the lifting device and pull the valve or valve operating mechanism, or to complete all maintenance tasks in place without removing the valve.

5. 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

Human Factors Engineering – Design for process safety critical tasks	DEP 30.00.60.19-Gen.
Human Factors Engineering – Workspace Design	DEP 30.00.60.20-Gen.
Piping – General Requirements	DEP 31.38.01.11-Gen.
Instruments for Measurement and Control	DEP 32.31.00.32-Gen.

AMERICAN STANDARDS

Applications Manual for the Revised NIOSH Lifting Equation	NIOSH 94-110

INTERNATIONAL STANDARDS

Ergonomic principles in the design of work systems	ISO 6385