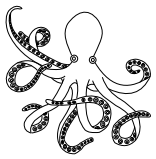
CCO Ltd

Diving management studies
Study No 10

Working at height during the mobilization and the maintenance of diving and ROV systems

21 October 2021

Page left blank intentionally



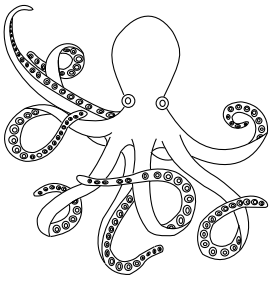
52/2 moo 3 tambon Tarpo 65000 Phitsanulock - Thailand

Tel: +66 857 277 123
E mail: info@ccoltd.co.th

Important Note

This study is written with the only aim of informing people interested in diving and ROV activities of the elements to take into account to prepare successful operations.

Christian CADIEUX - author



52/2 moo 3 tambon Tarpo 65000 Phitsanulock - Thailand

Tel: +66 857 277 123
E mail: info@ccoltd.co.th

Tables of contents

Page left blank intentionally

Purpose of this study

Reports from client representatives show that numerous mistakes are made regarding work at height during the mobilization and the maintenance of diving and ROV systems. The main reasons for these mistakes can be classified as follows:

- Use of inappropriate or faulty equipment.
- Incorrect use of provided equipment.
- Suitable equipment not provided.
- Workers who are not conscious of dangers or/and focusing on other aspects of the job.
- Deliberate disregard of the safe practices regarding works at height.
- Processes not discussed during the toolbox talks
- These operations are often not integrated into the mobilization plan.

Even though these incidents generally have no consequences, they may trigger accidents resulting in permanent disabilities or fatalities. It is the reason the safety officers and client representatives report them.

The purpose of this document is to provide guidelines on the construction of safety systems designed for works at height and their optimal utilization to diving and ROV teams to avoid them having incidents and accidents. Most discussed guidelines are from the European standards. However, similar standards can be adopted. The documents taken as reference are listed below:

- EN 12811-1: Temporary works equipment - Part 1: Scaffolds - Performance requirements and general design.
- EN 12810-1: Facade scaffolds made of prefabricated elements - Part 1: Product specifications.
- EN 12810-2: Facade scaffolds made of prefabricated elements - Part 2: Methods of particular design and assessment.
- EN 74: Couplers, spigot pins and baseplates for use in falsework and scaffolds - Part 1: Couplers for tubes - Requirements and test procedures.
- EN 338: Structural timber - Strength classes.
- EN 131-1: Ladders - Part 1: Terms, types, functional sizes
- EN 131-2: Ladders - Part 2: Requirements, testing, marking.
- EN 354: Personal fall protection equipment - Lanyards
- EN 355: Personal protective equipment against falls from a height - Energy absorbers
- EN 360: Personal protective equipment against falls from a height - Retractable type fall arresters.
- EN 361: Personal protective equipment against falls from a height - Full body harnesses.
- EN 362: Personal protective equipment against falls from a height - Connectors.
- EN 363: Personal protective equipment against falls from a height - Fall arrest systems.
- EN 364: Personal protective equipment against falls from a height - Test methods.

- EN 365: Personal protective equipment against falls from a height - General requirements for instructions for use, maintenance, periodic examination, repair, marking and packaging.
- EN 1497: Rescue equipment - Rescue harnesses.
- United states department of labor. Part # 1926, Safety and health regulations for construction, - Scaffolds - Standard # 1926.451.

Note that the drawings provided in this study are from the author. However, like the texts, they are often similar to those of the standards taken as references for consistency reasons and because this study aims not to provide new guidelines but to promote those that are considered relevant to prevent accidents. Note that this document is published free of charge as most readers it is designed for do not have the financial resources to buy the totality of papers taken in reference. Also, note that hanging baskets, self elevated platforms, and other mechanical systems are not discussed in this document.

Regarding the European Standards and the European Committee for standardization:
European Committee for standardization (CEN) is an organization based in Brussels (Belgium) that groups the national industrial standards of the members of the European Union plus some external members such as members of the European Free Trade Association (EFTA).
European Standards (EN) are a vital component of the European market, and for this reason, they cover nearly the totality of industrial activities. They are designed and created by all interested parties through a consensual process.
The European Committee for Standardization governance is composed of the general assembly, the presidential committee and its advisory bodies, and the administrative board. Other bodies such as technical boards, committees, and working groups support the achievement of the scope of the organization.
These standards are commonly used for the fabrication of devices such as chambers, helmets, regulators, gas cylinders, scaffoldings, ladders, harnesses, etc. Tools built according to these standards are marked with the initials “CE”.
Note that these standards are distributed through the normalization bodies of the members. For this reason, the mention “EN” is usually preceded by the name of the normalization body of the country it is sold in.

The following countries are members of the European Community or associated countries for the publication of these standards:

- Austria : ON (Österreichisches Normungsinstitut)
- Belgium : NBN (Bureau de normalisation/Bureau voor Normalisatie
- Bulgaria : BDS (Bulgarian Institute for Standardisation)
- Cyprus : CYS (Cyprus Organisation for Standardisation)
- Denmark : DS (Dansk Standard/Danish Standards)
- Estonia : EVS (Estonian Centre for Standardisation)
- Finland : SFS (Suomen Standardisoimisliitto r.y.)
- France : AFNOR (Association française de normalisation)
- Germany : DIN (Deutsches Institut für Normung e.V.)
- Greece : ELOT (Hellenic Organization for Standardization)
- Hungary: MSZT (Hungarian Standards Institution)
- Ireland : NSAI (National Standards Authority of Ireland)
- Iceland : IST (Icelandic Standards)
- Italy : UNI (Ente Nazionale Italiano di Unificazione)
- Latvia : LVS (Latvian Standards Ltd)
- Lithuania : LST (Lithuanian Standards Board)
- Luxembourg : ILNAS (Institut luxembourgeois de la normalisation, de l'accréditation, de la sécurité et qualité des produits et services)
- Malta : MSA (Malta Standards Authority)
- Nederlands: NEN (Nederlands Normalisatie-instituut)
- Norway : SN (Standard Norway)
- Spain : AENOR (Asociación Española de Normalización y Certificación)
- Poland : PKN (Polish Committee for Standardization)
- Portugal : IPQ (Instituto Português da Qualidade)
- Czech Republic: UNMZ (Czech Office for Standards, Metrology and Testing)
- Romania: ASRO (Association roumaine de normalisation)
- United kingdom : BSI (British Standards Institution)
- Slovakia : SUTN (Slovak Standards Institute)
- Slovenia : SIST (Slovenian Institute for Standardization)
- Sueden : SIS (Swedish Standards Institute)
- Switzerland : SNV (Schweizerische Normen-Vereinigung)

1 - Description

Works are considered at height when:

- The working activity is above areas where people are transiting or working
- The working area is below levels where people are working or transiting
- The working area cannot be reached from the floor and specific equipment such as steps, ladders, scaffoldings, ropes, winches, elevating platforms, and others must be used to access to it safely
- There are openings in the floor where the workers could fall
- The surface on which the work is planned is fragile and the workers could fall through it

Divers and technicians may need to work at height during the dive and ROV systems' mobilization and maintenance. They also may have to work close to structures where simultaneous works are in progress. Depending on the situations described above, they can be exposed to the following hazards:

- Falls to the deck or the sea
- Falling objects
- Exposure to weather conditions (cold or heat), suspension trauma, vertigo, & fatigue.
- Unstable working conditions
- Equipment failure

Working at height can be undertaken only when the task is essential and other alternatives have been considered and eliminated.

- An analysis should be performed to see whether other solutions can be used to perform the job from the floor.
- A risk assessment should be done to make sure that the selected solutions are safe.

If the best solution is working at height, there should be work equipment, or other measures to prevent falls.

- Collective protection such as barriers, guard rails, and nets should be installed.
- Personal equipment such as harnesses + fall arresters should be worn, adjusted and connected to proper hanging points.

2 - Means of access commonly used

2.1 - Scaffoldings

Scaffolds are elevated platforms that support workers and materials. They are commonly used offshore by teams in charge of the maintenance and construction of platforms. They are also sometimes used by diving & ROV teams for the mobilization or the maintenance of diving & ROV systems. Their size and complexity vary according to the work to be performed and the configuration of the workplace.
Scaffolds incorrectly erected may be dangerous for the workers working on them. Many accidents have happened due to the failure of components, which have sometimes resulted in the collapse of the entire structure. Even on sound scaffolds, workers can slip or lose their balance and fall. For these reasons, scaffolds must be designed, assembled, inspected, and dismantled only by competent persons and according to the manufacturer's instruction.

2.1.1 - Configuration

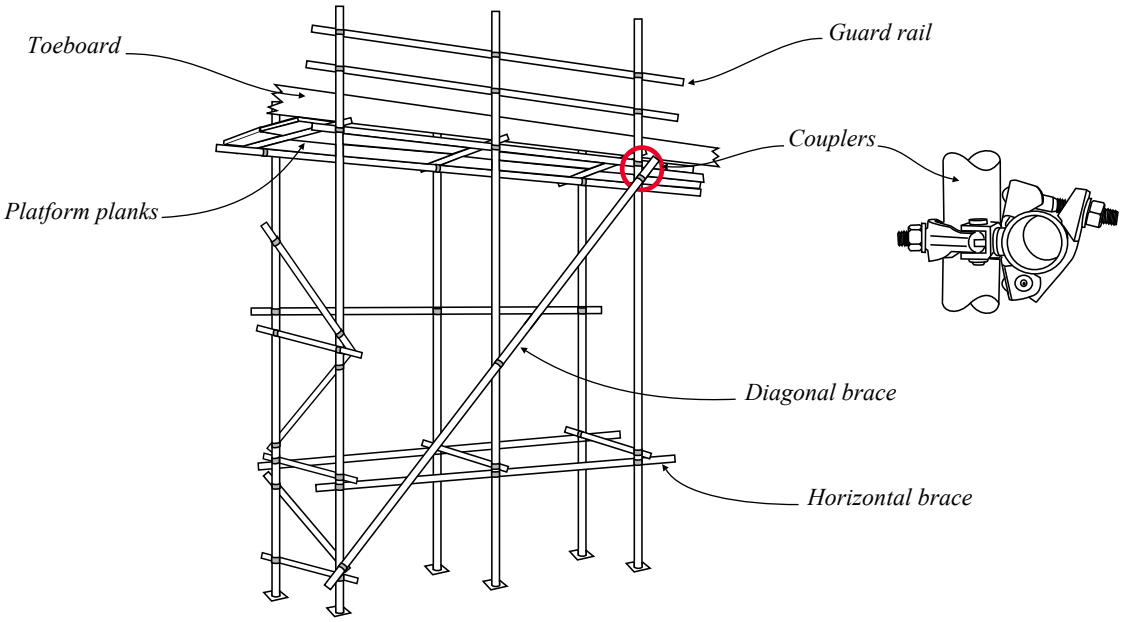
Relevant information should be provided to the team in charge of the scaffold to ensure an accurate and proper design process is followed. This information should include:

- The place where the scaffold is to be erected and its access.
- The period of time the scaffold is planned to be used.
- The purpose of erecting the scaffold.
- The dimensions of the scaffold.
- The loads planned to be transferred or stored on the scaffold and the number of people using it at any one time.
- The type of access planned (staircase, ladder bay, external ladders).
- Whether there are people working at the direct proximity of the scaffold, and there are requirements for additional protections such as netting and barriers.
- The specific requirements or provisions. For example, pedestrian walkways, and mechanical handling plants such as lever hoists and others.
- The nature of the supporting structure and the possible restrictions on tie locations.
- Any restrictions that may affect the erection or dismantling process.
- Note that most scaffolds erected in the offshore industry are made of tubes.

To summarize, each working scaffold must be designed, constructed, and maintained to ensure that it does not collapse or move unintentionally and so that it can be used safely. European standards say that scaffolds should be calculated to support their maximum intended load and dynamic effects from material placed on the working area by powered plants. Note that scaffolds erected for the mobilization of diving and ROV systems are usually small and installed for a short

time. Thus, they typically do not have the complexity of those used on platforms or the construction of buildings. Also, as said previously, their calculation, erection, maintenance, and dismantling are to be done by specialists and are not under the diving team's responsibility. For this reason, this topic is limited to only some essential information.

Scaffolds should be assembled according to recognized standards (for example, the European standard EN 12811-1). Note that the norm used may vary from one country to another, but the principle remains the same. Their components should be designed to be safely transported, erected, used, maintained, dismantled, and stored. Their basic structure usually consists of vertical tubes (posts), horizontal and diagonal braces secured by couplers to provide a rigid assembly.



Materials used to erect the scaffold should fulfill the requirements given in a recognized standard standards. They should be free from any impurities and defects which may affect their use. A competent person should inspect them before use.

- Tubes incorporated in prefabricated components for scaffold systems should conform to a standard equivalent to EN 12810-1. In this standard, steel units should have an external diameter of 48.3 mm for 2.7 to above 2.9 mm of thickness, depending on the elasticity required (315 to 235 N/mm²). This norm also says that aluminium tubes should have the same external diameter as steel units for a thickness of 3.2 mm to above 4 mm, depending on the elasticity limit selected (250 to 195 N/mm²).
- Regarding the items used solely for side protection other than toe-boards, the European standard En 12811-1 says that they should have a minimum nominal wall thickness of 1.5 mm. A lesser thickness may be used if the serviceability and load-bearing capacity are ensured, for instance, by using stiffening sections, bracing, or shaping of the cross-section. For toe-boards, the minimum nominal wall thickness shall be 1,0 mm.
- Couplers should conform to the standard EN 74, or an equivalent one. Note that the norm according to which they are built should be engraved to them.

- European standard 12811-1 says that the platform units and their immediate supports should have a minimum nominal thickness of 2,0 mm. A lesser thickness may be used if the serviceability and load-bearing capacity are ensured, for instance, by using stiffening sections, bracing, or shaping the cross-section. Note that other standards recommend 2.5 mm thickness.
    - Timber should be stress graded in accordance with the European standard EN 338 or an equivalent standard. If a protective coating is used, it should not prevent the discovery of defects in the material.
    - European standards say that plywood for platform units should have at least five plies, a minimum thickness of 9 mm, and a good resistance to weather conditions.
    - Platform units assembled ready for use should be capable of retaining a circular steel bar of 25 mm diameter and 300 mm length falling endwise from a height of 1 m.

Plywood *Metal (Aluminium or steel)* *Timber*

European standards recommend to apply the following dimensions regarding the size of a scaffold.

- The width “W” is the entire width of the working area. The European standard EN 12811-1 says that it includes up to 30 mm of the toeboard (see Figure 1 below). This standard classifies widths into seven classes that are displayed in Table 1 below. Note that the authorities of some countries lay down minimum widths according to the activities intended.

Figure 1

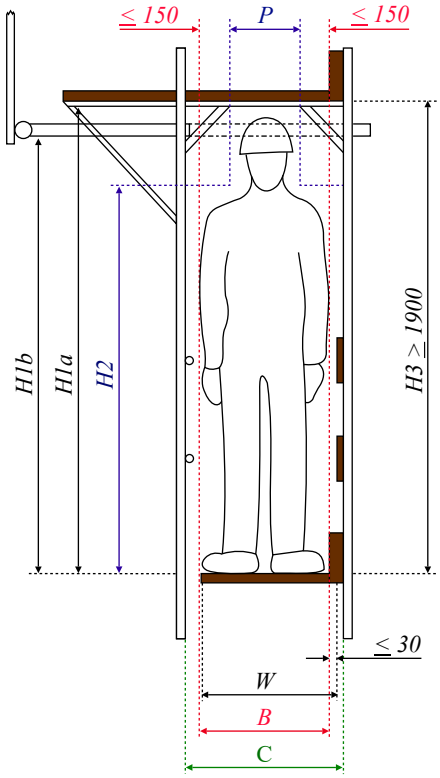


Table 1 - Width classes

Width class	*W in metres*	*Width class*	*W in metres*
W06	*0,6 < W < 0,9*	*W18*	*1,8 < W <2,1*
W09	*0,9 < W < 1,2*	*W21*	*2,1 < W < 2,4*
W12	*1,2 < W <1,5*	*W24*	*2,4 ≤ W*
W15	*1,5 < W <1,8*		

- The dimension “C” is the distance between the vertical posts. It should be at least 600 mm, and the width of stairways should not be less than 500 mm.
- Each working area, including the corners, should have its specified width along its entire length. There should be an utterly unimpeded area with minimum width “B” at shoulder level and “P” at head level as per in figure 1. According to EN 12811-1, the minimum width for the head should be more significant than 300 mm. However, the authorities of many countries require a larger minimum space.
  Consideration should be given to maintaining space for work and access when equipment or materials are placed on the working area.
- The minimum clear headroom “ H3” is the free space below the ceiling when the scaffold has multiple stages. According to EN 12811-1, It should not be less than 1,90 m. However, more reduced spaces are agreed between working areas and transoms (see heights H1a & H1b in figure 1 above and Table 2 below).
  Note that there should be a minimum clear height at shoulder level (see “H2” in table 2 and figure 1).
  Similar to the widths these minimum heights may vary from a standard to another and a country to another.

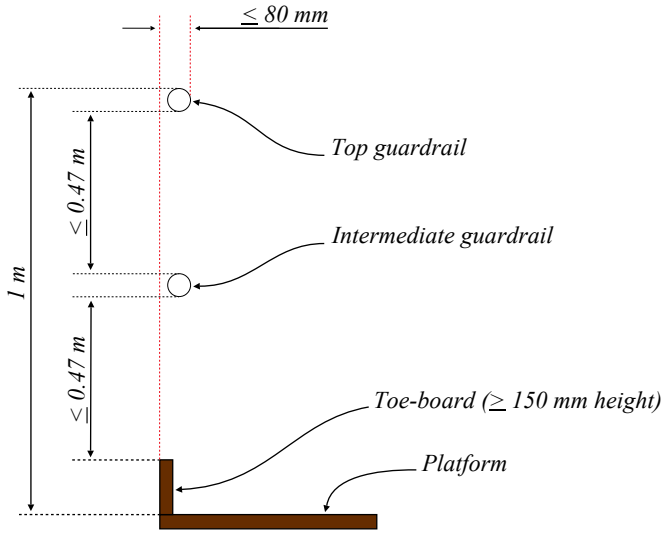
Table 2 - Headroom classes

Class	***Clear headroom***		
	Between working areas H3	***Between working areas and transoms or tie members H1a, H1b***	***Minimum clear height at shoulder level H2***
1	*H3 > 1,90 m*	*H1a > 1,75 m < 1,90 m* *H1b >1,75 m < 1,90 m*	*H2 > 1,60 m*
2	*H3 > 1,90 m*	*H1a > 1,90 m* *H1b > 1,90 m*	*H2 > 1,75 m*

Side protections should be in place. At the minimum, they consist of a principal guardrail, intermediate side protections, and a toeboard (see Figure 2 below). Note that stairways may be dispensed of toe-boards. The European standard EN 12811-1 gives the following information:

- The principal guardrail should be installed at 1 m or more above the adjacent level of the working area.
- Intermediate side protections should be fixed between the top guardrail and the toeboard. They may consist of one or more intermediate bars, frames, or fencing structures. They should be dimensioned so that a sphere with a diameter of 470 mm cannot pass through them.
- Toe-boards should be fixed so that their top edge is at least 150 mm above the adjacent level of the working area. Holes and slots in a toeboard should not be larger than 25 mm in one direction except for those used for handling.
- The horizontal distance between the outer face of the toeboard and the inner face of the guardrail and all the components of the intermediate side protection should not exceed 80 mm.

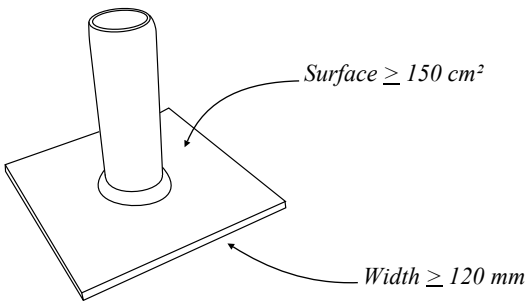
Figure 2



- Where cladding of the working scaffold is required, the scaffold should be clad with either netting or sheeting.

- The strength and rigidity of the base plates and base jacks should be sufficient to ensure that it can transmit the maximum design load from the working scaffold to the supporting structure. The area of the end plate should be a minimum of 150 cm². The minimum width must be 120 mm. They should conform to the European standard EN 74 or a similar standard.

Figure 3



- EN 12811-1 says that when used, base jacks must be provided with a centrally positioned which inclination that does not exceed 2,5 %. The minimum overlap length at any position of adjustment should be 25 % of the total length of the shaft, or 150 mm whichever is greater. The thickness of the endplate must be at least 6 mm. Shaped endplates must have at least the same rigidity.

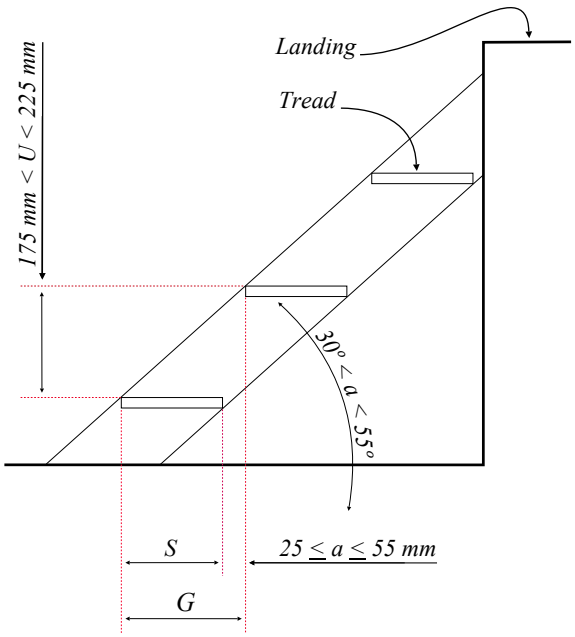
Safe and ergonomic means of access to the scaffold and must be provided. They are inclined ladders or stairs that must be within the platform within a widening of the working scaffold at one bay or in a tower immediately adjacent.

- Ladders must be in accordance with recognised standards. Note that EN 131-1 and EN 131-2 that are described in the section “ladder” of this chapter are in force in many countries.
- European Standard EN 12811-1 specifies two classes of stairway dimensions that should be in accordance with Figure 3 and Table 3 below:

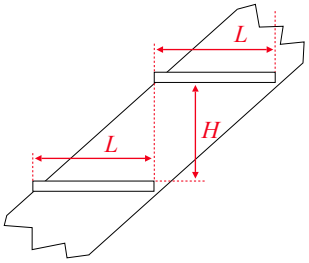
Table 3: Stairway dimensions

Dimension	Class	
	A (mm)	B (mm)
S	$125 \leq S \leq 165$	$S \geq 165$
G	$\geq 150 \leq G < 175$	$G \geq 175$
Minimum clear width 500 mm		

Figure 4

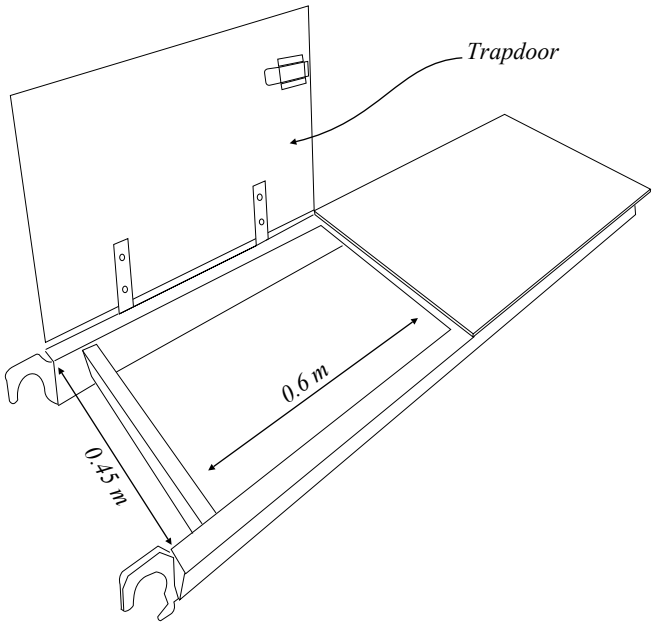


Formula used by carpenters to calculate stairs easy to climb: 63 - (H x 2) = L



Openings may be installed in platforms to allow access from one level to another one. EN 12811-1 says that their dimensions should be at least 0,45 m wide, measured across the width of the platform, and 0,60 m long (see Figure 5 below). This document also says that a protective railing should be installed if it is not possible to close the opening by a permanently attached trapdoor.

Figure 5



Scaffolds must be calculated to withstand loads and equipment transferred, stored, and operated on them. That includes the dynamic effects of materials planned to be transferred by cranes or other means. It must also be calculated to withstand the impact of the wind. The elements for these calculations are provided in the manufacturer’s documentation and official standards, such as the European standard EN 12811-1. Again these calculations are made by specialists and are not the responsibility of the diving and ROV teams. However, it is essential to detail the equipment intended to be stored and transferred to the team in charge of the design of the scaffold.

2.1.2 - Installation and certification

During their erection, access to scaffolds should be limited only to the technicians building them:

- There must be a tag system visible and positioned to the strategic points to manage and communicate the latest status of the equipment.
- Warning signs must be displayed, and barriers installed to prevent access of unauthorized persons.

Competent persons erecting scaffolds should hold official certificates. As an example, CISRS-UK (Construction Industry Scaffolder Record Scheme - UK) indicates the following levels:

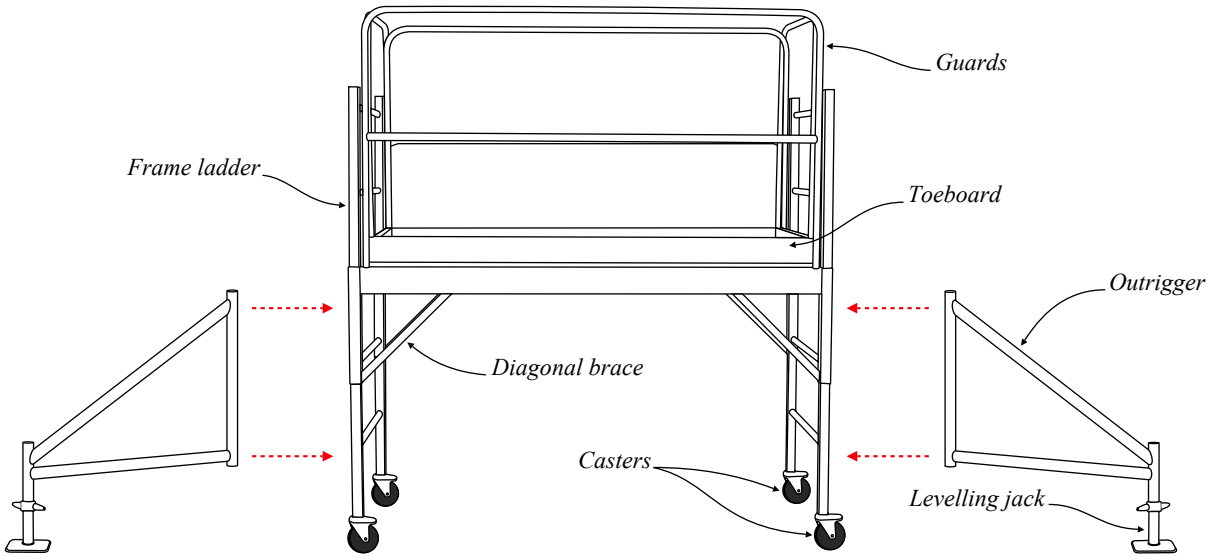
- “Scaffolding Labourer” has the knowledge of the basics of the industry.
- “Trainee scaffolder” has sufficient knowledge to safely erect and dismantle basic structures.
- “Basic scaffolder” has knowledge of different scaffolding structures and their implementation on construction sites.
- “Advanced scaffolder” has knowledge of complex scaffolding structures and the administrative elements to this area of construction.

A scaffold must not be used unless a certificate from a competent inspector states that it is safe for use and complies with the regulations. A scaffold register must be kept on site and be available for inspection.

- The scaffold register should record:
    - The project name and place where the project is carried out
    - The main contractor (name, address, contact name)
    - Where the scaffold is erected
    - The reason for using scaffolds
    - The scaffold subcontractor (name, address, contact name, phone number)
    - The subcontractors who are to use the scaffold.
    - The overall dimensions (length, height, width, etc.)
    - The number of working platforms
    - The duty of scaffold (light, medium, heavy, special, etc.).
    - The limitations (if any)
    - Comments.
    - Each inspection carried out.
- Inspections must be carried out at the following intervals:
    - Before the scaffold is first put into use
    - Weekly while the scaffold is in use
    - After each structural alteration or addition
    - Monthly while the scaffold is set up but not in use
    - After any storm or occurrence that could adversely affect the safety of the scaffold
- Inspections must be carried out by either a certificated scaffolder of the appropriate class, or a competent person such as a registered engineer.
- The entries of each inspection in the scaffold register must be made and signed by the person who carried out the inspection.

2.1.3 - Rolling & light scaffolds

Rolling scaffolds are light rigid structures set on castors and designed to stand by themselves. Their castors are provided with swivel locks or equivalent means to prevent unwanted movement when they are in use. OSHA requires that each castor be equipped with a brake to ensure the safety of employees. Note that the wheels can be replaced by levelling jacks with base plates if necessary.
These scaffolds are composed of pre-assembled elements designed to avoid mistakes during their erection and intended to be set up by people who are not specialists. They allow reaching limited heights, although units allowing to work at 9 m exist. OSHA recommends that their height to base width ratio is 2:1 or less. For this reason, outriggers are provided to reinforce the stability of the highest units. They should be installed on each corner to extend the base of the structure. The advantages of such devices are that they allow for frequent change of position and can be stored ready for immediate use in the corner of the workshop. Their main inconvenience is that they can be used only on flat surfaces with a slope of less than 3 degrees. Another inconvenience is that they allow working only in small areas with a load and number of workers limited to the specifications provided by the manufacturer.
Such units may be used for light tasks in place of classical scaffolds during the mobilization and the maintenance of diving systems on stable vessels in port when equipped with base plates in place of the castors and provided with outriggers. Of course, using base plates in place of wheels limits them to static use only. Also, units with more than one level should be erected by specialists. Two people are recommended for erecting a small unit. More specialists will be necessary for higher units. The manufacturer should provide the method and guidelines for the installation of the equipment.
Note that when hoisting materials or using side brackets, such scaffolds must be restrained from tipping by guying or tying to a permanent structure or other acceptable means.



Mishandling, trucking, and storing may cause damage to such scaffolding equipment. For this reason, it should be inspected in detail prior to erection and using it:

- Components should be straight and free from bends, kinks, or dents.
- Heavily rusted or eroded parts should be rejected.
- Welds should be checked, and any piece of equipment showing damaged welds or rewelding not performed in the factory should not be used.
- Locking devices on frames and braces should be in good working order, and if not, they must be repaired or replaced before use.
- Coupling pins must effectively align.
- Pivoted cross braces must have the centre pivot securely in place.
- Casters must be closely inspected. Their rolling parts must be in perfect conditions without flats, loss of materials, or loosened bearings. Also, their brakes must be in good working order to block each wheel when activated. If defects are detected, they must be repaired or the caster replaced before use.
- Levelling jacks should move freely on all their threaded length. If not, they must be replaced.
- The team must ensure that the height to base width ratio is at least 2:1. If not, appropriate outriggers must be installed to ensure that the scaffold is stable. Also, the slope of the floor must be checked to ensure it is less than 3 degrees. In case of more elevated values, or the installation on supports that can suddenly be outside these values, such as vessels, the wheels must be replaced by levelling jacks with base plates, and the scaffold must be restrained from tipping by guying or tying to a permanent structure or other acceptable means.
- Note that workers cannot stay on rolling scaffolds when they are moved on their wheels.

Rolling scaffolds should be inspected every day if used daily. However, when used as static scaffolds with base plates in place of the casters, the inspections can be organized as discussed in point 2.1.2.

2.2 - Ladders

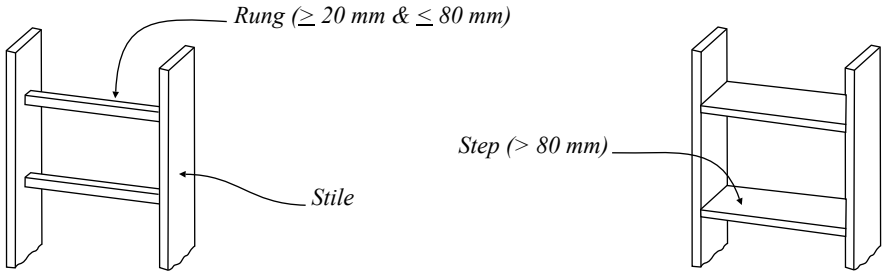
Ladders are devices incorporating steps or rungs on which a person may step to ascend or descend. They are used for gaining access to areas above or below the floor that are not provided with permanent access.

2.2.1 - Elements that compose a ladder

The document EN 131-1 provides the following definitions:

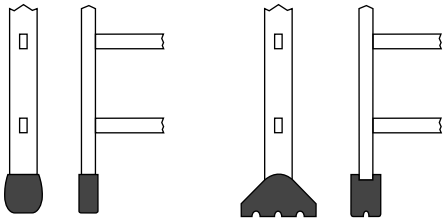
- The stiles are the lateral parts of a ladder that support the rungs or steps.
- The rungs are climbing supports with a standing surface of less than 80 mm and at least 20 mm
- The steps are climbing support with a standing surface equal to or greater than 80 mm

Figure 6



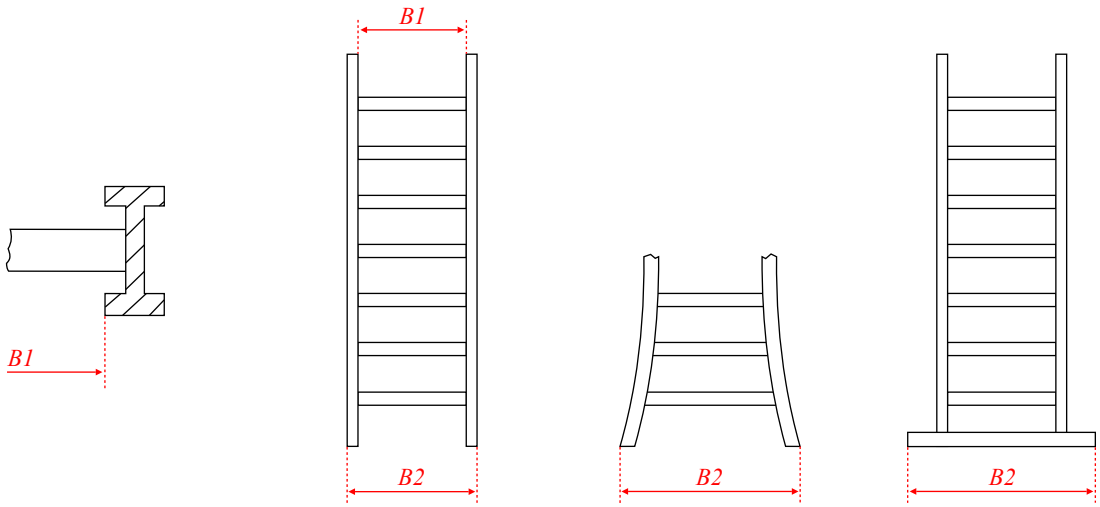
- The foot is the device fitted permanently to the bottom of ladders to prevent the ladder from slipping. In the case of a wooden ladder, it is the bottom of the stile.

Figure 8



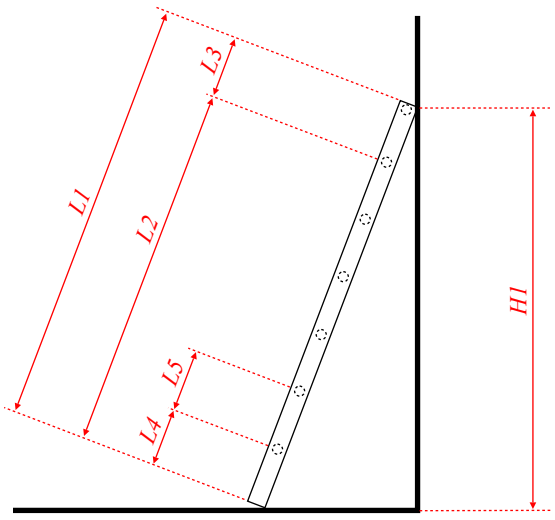
- The inner width is the usable distance between the inner sides of the stiles measured at the upper edge of the shortest rung/step/platform (see B1 in tFigure 9).
- The outside width is the distance between the outer side of the stiles measured at the lower end of stiles or the outer width of the supporting points of the stabilizer (see B2 in Figure 9).

Figure 9



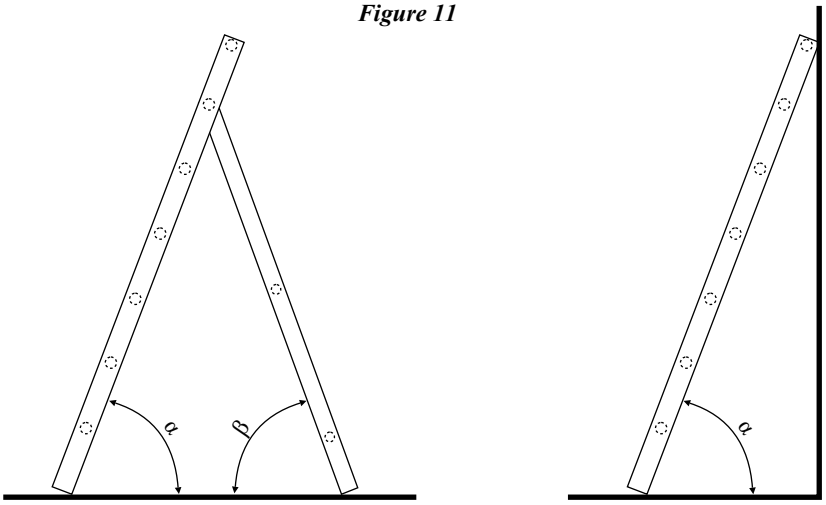
- The total length is the distance measured over the bottom foot to the top of a ladder (see L1 in Figure 10).
- The length to the topmost rung/step is the distance from the lower end of the ladder to the upper edge of the topmost rung/step or to the upper edge of the platform, measured in the middle line between the stiles (see L2 in Figure 10).
- The distance between the topmost rung and the upper end is the distance between the upper edge of the topmost rung to the upper end of the ladder, measured in the middle line between the stiles (see L3 in Figure 10).
- The distance between the bottom end and the lowest rung/step is the distance from the lower end of the ladder to the upper edge of the lowest rung/step, measured in the middle line between the stiles (see L4 in Figure 10).
- The distance between rungs/steps is the distance between the rungs/steps, measured in the middle line between the stiles from the upper edge of rung/step to the upper edge of rung/step or to the upper edge of platform (see L5 in Figure 10).
- The touch-down height is the vertical height measured from floor level to the top contact point, upper edge of a touch down rail or a hooking-in bar when the ladder is standing in its correct working position (see H1 in Figure 10).

Figure 10



- The inclination is the angle (α for ascending leg, for supporting leg) between the horizontal plane and the legs of the ladder (see in Figure 11 on the next page).

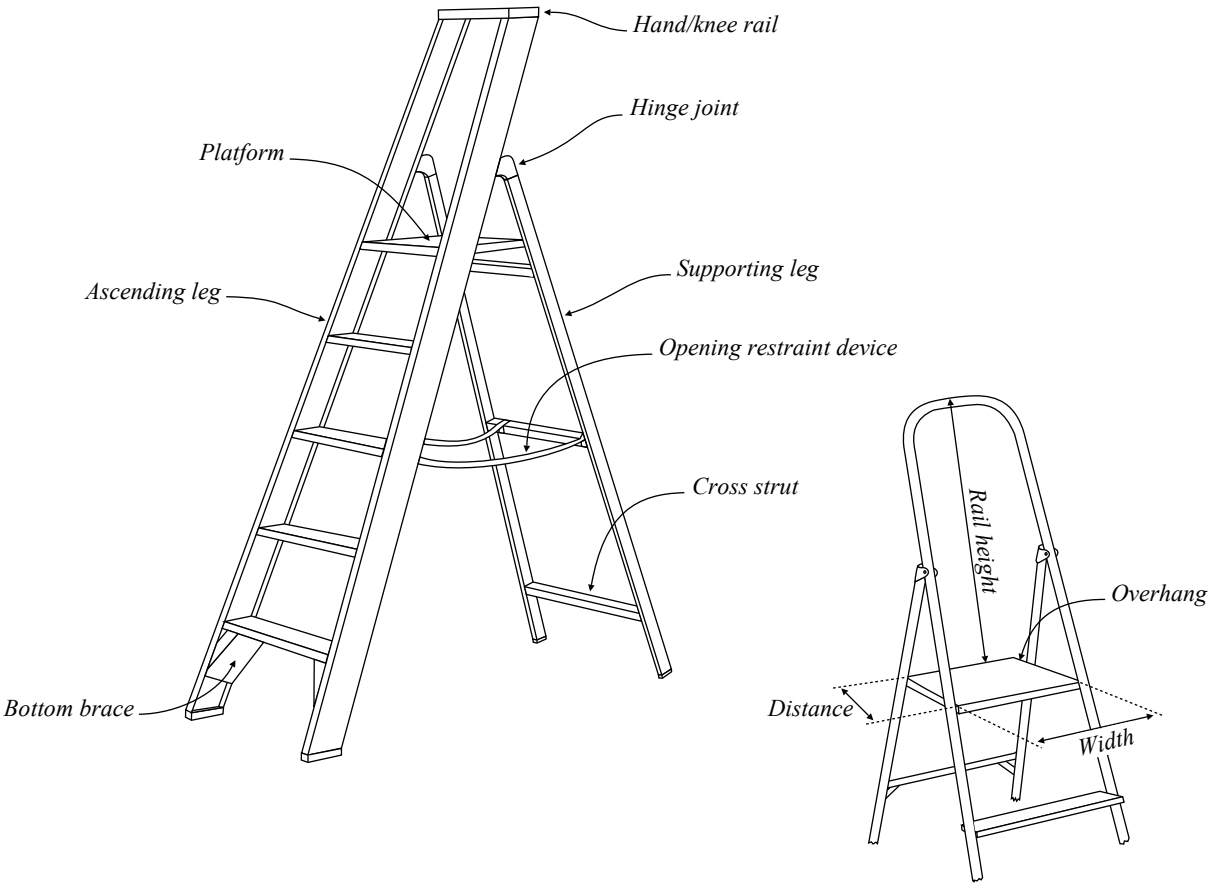
Figure 11



Standing ladders are designed to stand by themselves. They are composed of the following additional elements:

- The platform is the topmost standing surface, which is larger than a step.
- The ascending legs are the stiles of the ladder with climbing supports.
- The supporting legs are positioned antagonist to the ascending legs to maintain the ladder in standing position. They are usually deprived of climbing supports. Instead, cross struts are used to join the two stiles and make a stiff support.
- The Hand/knee rail is a prolongation of the stiles that allows gaining support above the platform level.
- The bottom brace secures to lower end of the stiles against buckling.
- The opening restraint devices secure the ascending and supporting legs from sitting apart. They may consist of articulated bars, ropes, metallic cable, or chains.
- Hinge joints secure the two legs of the ladder at the upper level and allow the opening and closure of the supporting legs along the ascending legs to allow for easy deployment, transportation, and storage of the standing ladder.
- The width of the platform is the distance between its left and right edges.
- The depth of the platform is the distance between its front and the rear edges.
- The overhang of the platform is the distance from the rear side of the support legs to its rear edge
- The hand-knee rail height is the vertical distance from the top edge of the platform to the top edge of the hand-knee rail.

Figure 12



2.2.2 - Models commonly used in the offshore industry (source: En 131- 1)

2.2.2.1 - Leaning rung ladders:
These ladders are of equal width over their total length or are wider at the bottom and/or top. Functional sizes are given in Table 4.

Table 4: Functional sizes of leaning rung ladders

	Inner width (B1) *	***Outer width (B2)****	***Clearance (CL)***	***Distance bottom end and lowest rung (L4)***	***Distance between rungs (L5)***	***Angle ascending leg (□)***
Min.	*280 mm*	*340 mm*	*–*	*0.5 X L5*	*250 mm*	*65°*
Max.	*–*	*–*	*45*	*L5 + 15*	*300 mm*	*75°*
**This size applies also to single parts of a ladder if they can be used separately e.g. as leaning ladder.*						

Figure 13: *One piece leaning ladder*

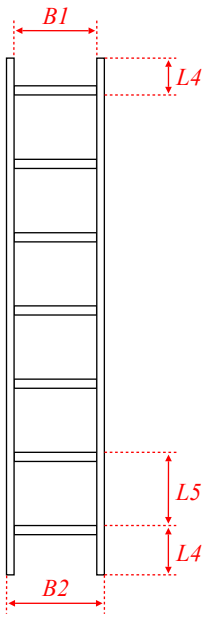


Figure 14: *Sectional ladder*

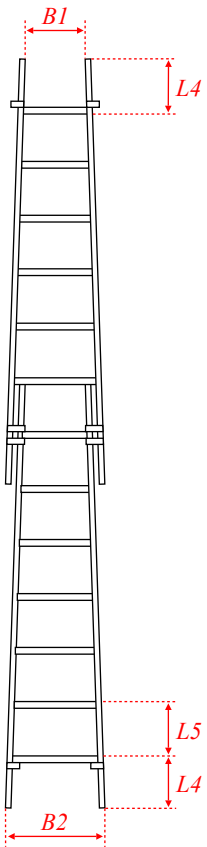
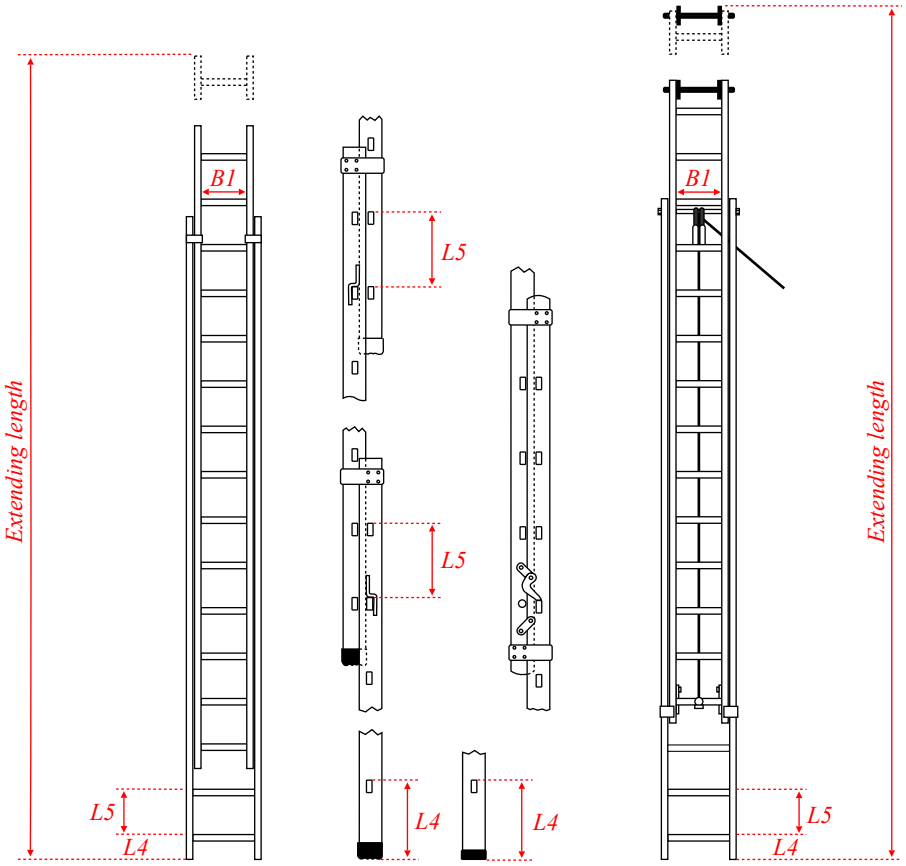


Figure 15: *Extending ladder*



Note: The dimension of the overlap depends on the calculation and design of the ladder. It is determined by the manufacturer. The function and carrying capacity of the overlap must be in accordance with the European standard EN 131-2 or an equivalent standard.

- Standing rung ladders

The legs of these ladders are connected with hinge joints and must be secured from sliding apart (see Table 5).

Table 5: Functional sizes of standing rung ladders

	Inner width (B1)	Outer width (B2)	Distance bottom end and lowest rung (L4)	Distance between rungs (L5)	Angle ascending leg (α)	Angle supporting leg (⏢)
Min.	*280 mm*	*B1 + 0.1* length to the topmost rung + 2 thickness*	*0.5 x L5*	*250 mm*	*65°*	*65°*
Max.	–	–	*L5 + 15*	*300 mm*	*75°*	*75°*
**The thickness of the stile is the outside dimension of the stile.*						

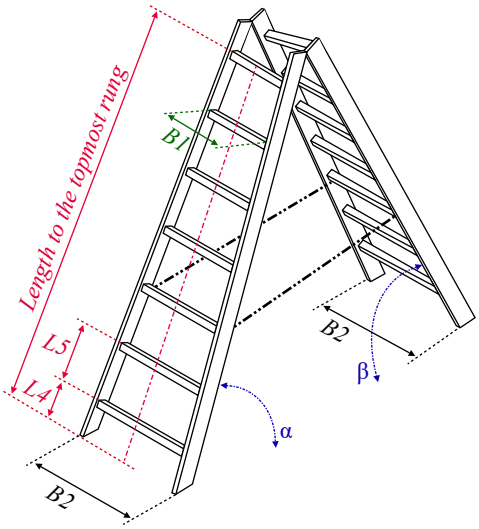


Figure 16: *Standing rung ladder with tapered leg*

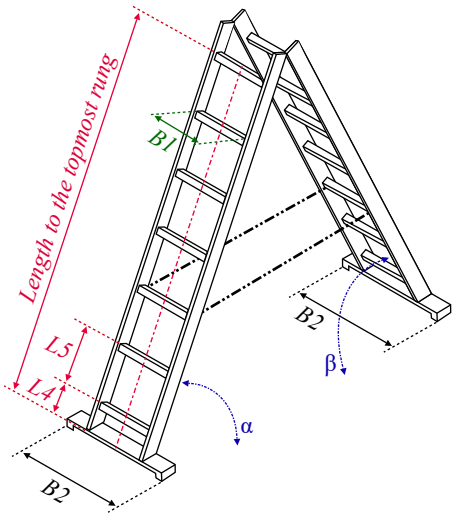
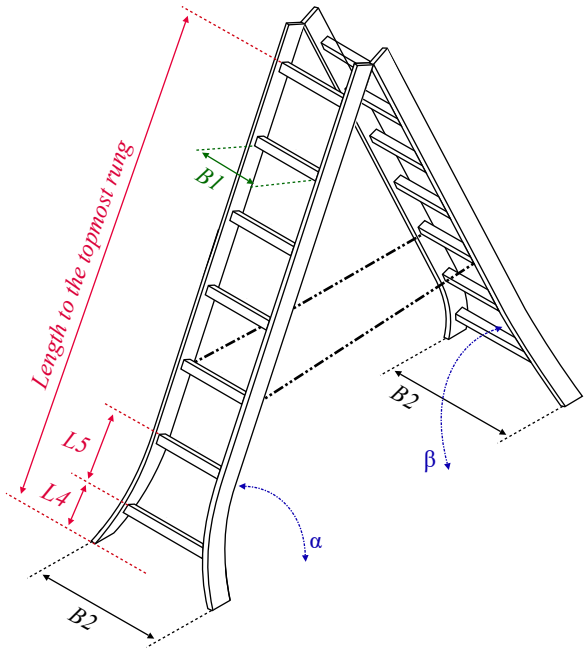


Figure 17: *Standing rung ladder with parallel stiles and stabilizers at the base of both sections*

Figure 18: *Standing rung ladder with parallel stiles splayed at the bottom*



- Combination ladders

Note: When combination ladders are used as standing ladders, parts must be secured from sliding apart.

- Two-piece combination ladder

Table 6: Functional sizes of two-piece combination ladders

	Inner width (B1)	***Outer width (B2)***	***Distance bottom end to lowest rung (L3)***	***Distance bottom end to lowest rung (L4)***	***Distance between rungs (L5)***	***Angle ascending leg (□)***	***Angle supporting leg (□)***
Min.	*280 mm*	*B1 + 0.15* length of combination ladder + 2 thickness*	*0.5 x L5*	*0.5 x L5*	*250 mm*	*65°*	*65°*
Max.	–	–	*L5 + 15*	*L5 + 15*	*300 mm*	*75°*	*75°*
**The thickness of the stile is the outside dimension of the stile.*							

Figure 19: *Combination ladder used as a standing ladder*

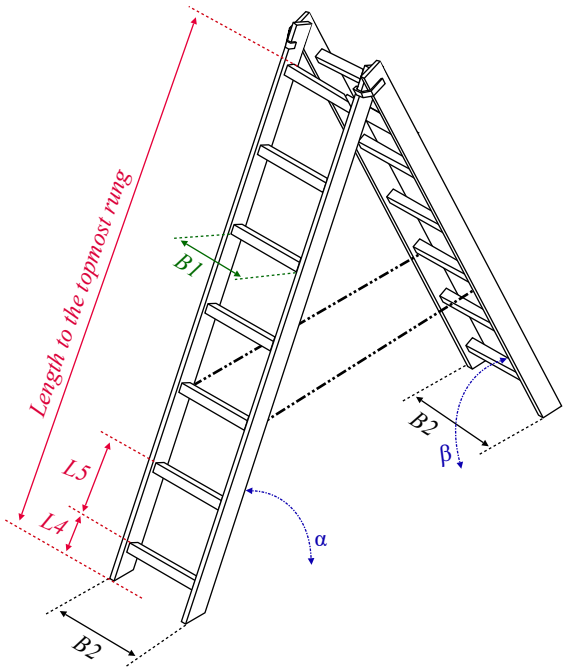


Table 7: Functional sizes of three-piece combination ladders

	Inner width (B1)	*Outer width (B2)*	*Distance bottom end to lowest rung (L3)*	*Distance bottom end to lowest rung (L4)*	*Distance between rungs (L5)*	*Angle ascending leg (□)*	*Angle supporting leg (□)*
Min.	*280 mm*	*B1 + 0.175* length of combination ladder + 2 thickness*	*0.5 x L5*	*0.5 x L5*	*250 mm*	*65°*	*65°*
Max.	–	–	*L5 + 15*	*L5 + 15*	*300 mm*	*75°*	*75°*
**The thickness of the stile is the outside dimension of the stile.*							

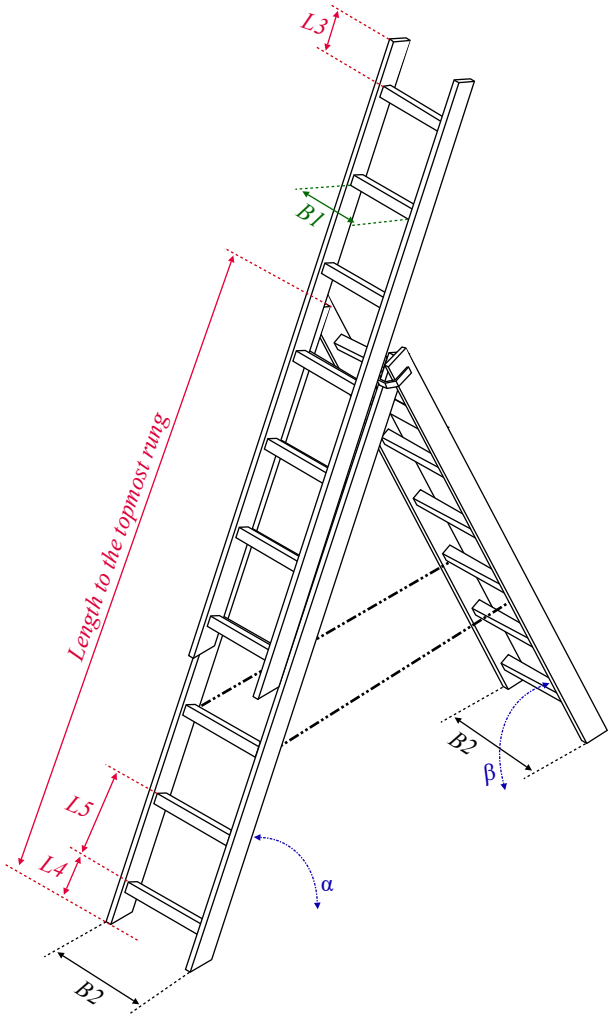


Figure 20: *Combination ladder used as a standing ladder with an extending ladder at the top*

- Leaning step ladders

These ladders are of equal width over their total length or they are wider at the bottom and/or the top.
The permissible inclination α applies to the height of the touch down surface above the floor level when the steps are in horizontal position. Functional sizes are given in Table 8.

Table 8: Functional sizes of leaning step ladders

	Inner width (B1) *	**Outer width (B2)***	**Distance bottom end and lowest rung (L4)**	**Distance between rungs (L5)**	**Angle ascending leg (α)**
Min.	*280 mm*	*340*	*0.5 X L5*	*230 mm*	*60°*
Max.	–	–	*L5 + 15*	*300 mm*	*70°*

Figure 21: *Leading step ladder*

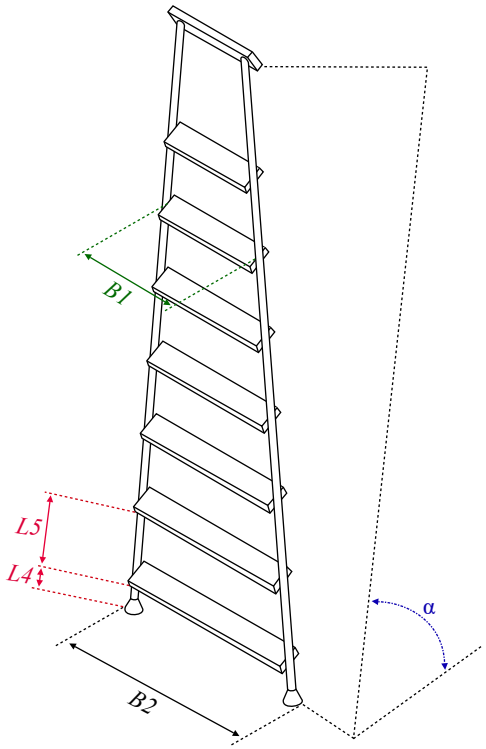


Table 8: Functional sizes of standing step ladders

	Inner width (B1)	Outer width (B2)	Platform overhang (C)	Hand /knee rail height (D)	Distance bottom end to lowest rung (L4)	Distance between rungs (L5)	Width of platform (L6)	Depth of platform (L7)	Angle ascending leg (α)	Angle support--ing leg (⏢)
Min.	*280 mm*	*B1 + 0.1* length to the topmost rung/step + 2 thickness*	–	*600 mm* **	*0.5 x L5*	*230 mm*	*250 mm* ***	*250 mm*	*60°*	*65°*
Max.	–	–	*30 mm*	–	*L5 + 15*	*300 mm*	–	–	*70°*	*75°*

** The thickness of the stile is the outside dimension of the stile.*
*** Measured vertically*
**** It must be possible to inscribe of 250 mm x 250 mm in the platform.*

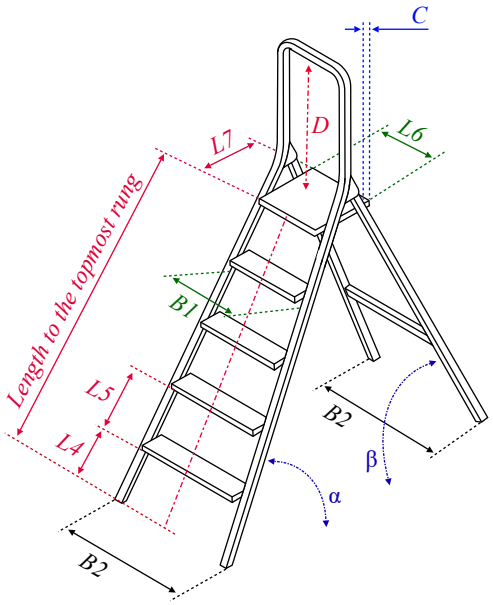


Figure 22: *Unilaterally ascendable standing step ladder*

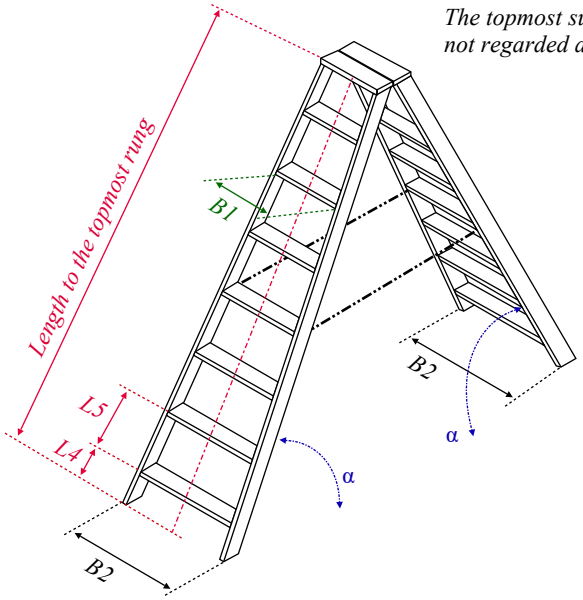


Figure 23: *Bilaterally ascendable standing step ladder*

2.2.3 - Procedures for use

- 2.2.3.1 - Risk assessment

Ladders can be used for work at height when the risk assessment has demonstrated that using equipment offering a higher level of fall protection is not justified.
Note that vessels at sea are following the movement of the waves. As a result, the ladder may become unstable. For this reason, means of fastening must be studied during the risk assessment to make sure that the ladder will be perfectly stable.

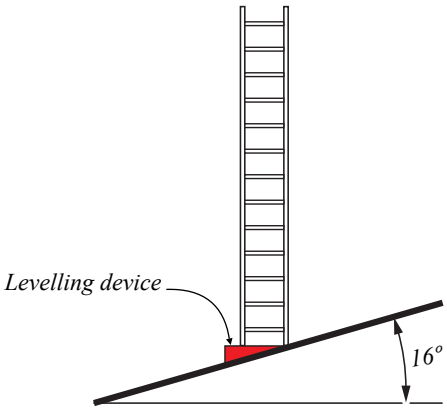
- 2.2.3.2 - Check the condition of the ladder

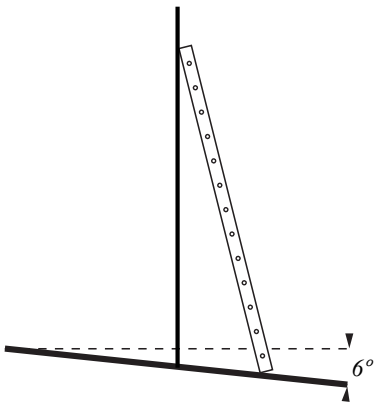
- The ladder should conform to a recognized standard. Note that some standards, such as the European standard En 131-1/2017, classify the ladders into several categories (professional and non-professional use). Of course, the ladders used on the worksite must conform to the norm according to which they are built. However, authorities of most countries say that teams can continue to use ladders purchased before the modification of such a standard.
- The stiles must be in perfect condition. Ladders with stiles that are bent or have cracks (even minor) must not be used.
- The feet must be in place and in good condition.
- There must not be missing rungs or steps. The rungs /steps must not be bent or presenting structural faults such as cracks or be slippery.
- Locking mechanisms must be in perfect condition. The operator must make sure that it cannot be disengaged accidentally.

- 2.2.3.3 - Install the ladder

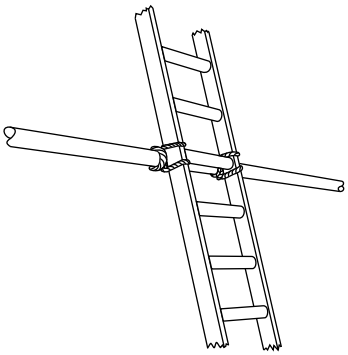
- The floor must be levelled: For ladders, the maximum safe floor slopes on a suitable surface (unless the manufacturer states otherwise) are as follows:
  - side slope 16° (but the rungs still need to be levelled)
  - back slope 6°

  Note: Ladders must be levelled using specially designed devices and not moveable objects such as pallets.





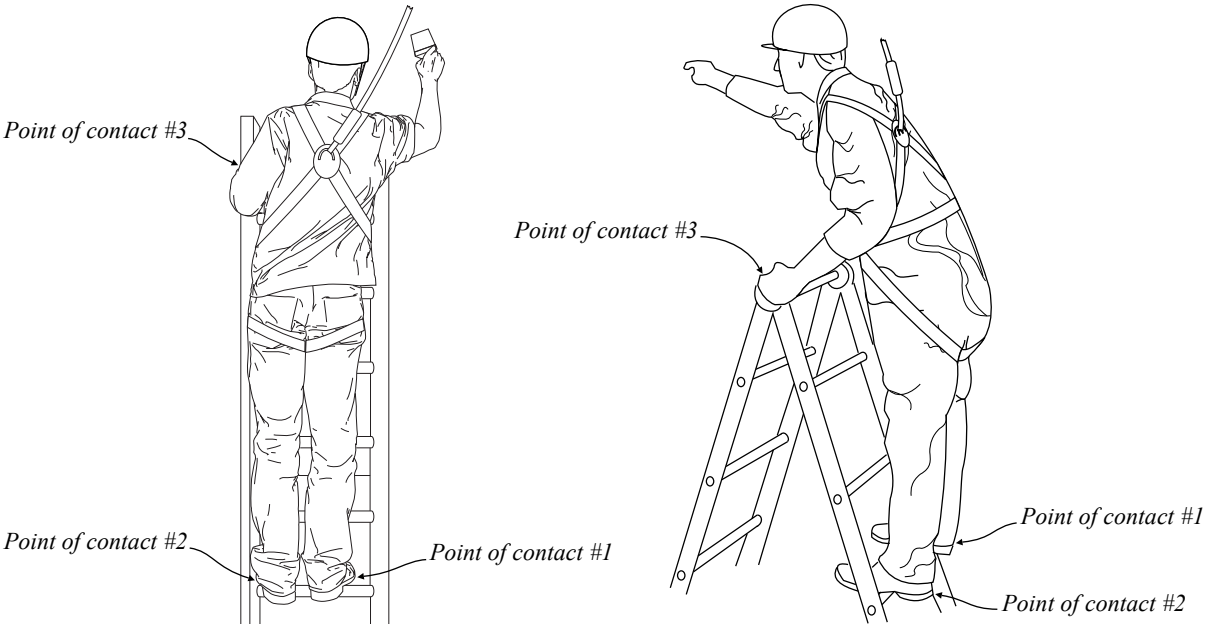
- Standing step ladders and combination ladders used as standing ladders must have the four feet in contact with the floor.
- The angle of the ladder should conform to the angle α and β indicated in Tables 4; 5; 6; 7; 8 in point 2.2.2, which are those of European standard EN 131-1, or an equivalent standard. A common quick calculation with leaning ladders is to apply the 1 in 4 rule (1 unit out for every 4 units up) that is giving an angle of 75°.
- The floor must be clean and not be slippery (no oil).
- As explained before, a boat is not a stable support. Also the floor may be slippery despite an appropriate cleaning. For this reason, the ladder must be secured to suitable points such as handle rails, pad eyes, and/or any solid part of the structure using ropes, cargo straps and slings to prevent it from falling.



- Ladders used for access should project at least 1 m above the landing point and be tied; alternatively a safe and secure handhold should be available.

- The ladder must not be overloaded: The workers' weight and the equipment or materials they are carrying must be considered. The maximum weight a ladder can withstand can be found on the documentation supplied by the manufacturer or the information label that must be displayed on the ladder.
- Barriers and warning signals must be installed to isolate the area where the ladder is erected. If necessary, some members of the team may be employed to guard the access to the job site.

- 2.2.3.4 - Use the ladder
  - Ladders should not be used in strong or gusting winds.
  - If using a standing step ladder, it should face the work activity.
  - The worker should not use the top three rungs of a ladder. If using a standing step ladder, the three last steps should not be used unless a suitable handrail is available.
  - The worker must always grip the ladder and face the ladder rungs while climbing or descending.
  - The worker should never slide down the stiles
  - The worker should avoid holding items when climbing
  - The worker must maintain three points of contact when climbing (this means a hand and two feet) and wherever possible at the work position.



2.3 - Personal fall protection systems *(EN 363)*

2.3.1 - Description

Personal fall protection systems protect the user against falls from a height by either preventing or arresting free falls. They include:

- Restraint systems;
- Work positioning systems;
- Rope access systems;
- Fall arrest systems;
- Rescue systems.

The documents EN 363 says that a personal fall protection system includes a body holding device that is attached to a reliable anchorage point via an attachment system, which consists of one or more components that are normally included in the system in accordance with its intended use (e.g. lanyards, connectors, fall arresters, anchor devices).
The European standard EN 363 also says that the elements to take into account should include:

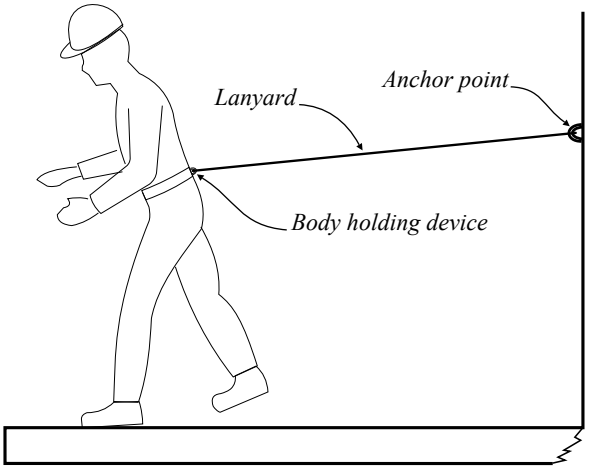
- The suitability of the components for the intended use, taking into account all the different phases of use..
- The characteristics of the workplace. As an example, the inclination of the workplace or the location of the anchor device.
- The intended user. That includes his size and his level of competence.
- The compatibility of the components (e.g. interaction between anchor device and other components).
- The ergonomic considerations. For example, by choosing the most comfortable harness and attachment elements to minimise discomfort and stress to the body.
- The information regarding components
- The possibility to organize safe and effective rescue operations and prevent suspension trauma.
- The characteristics of the anchorage. That includes its location and strength.

2.3.2 - Personal fall protection systems commonly used

- 2.3.2.1 - Restraint system

EN 363 says that a restraint system is a personal fall protection system that prevents falls from a height by restricting the travel of the user.

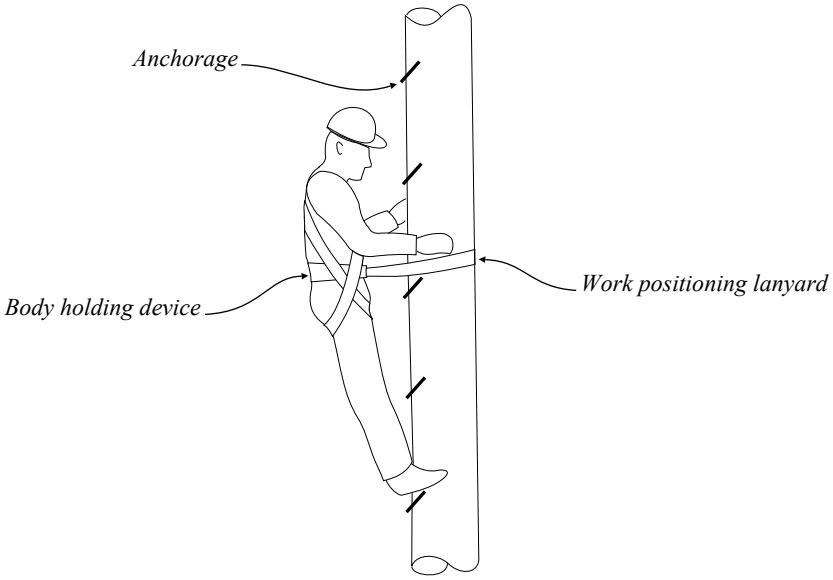
- It is not intended to arrest a fall from a height. Thus, it is not intended for work in situations where the user needs support from the body holding device.
- It must be assembled in such a way that the user is prevented from reaching areas or positions where the risk of a fall from a height exists.
- Any suitable body holding device and lanyard may be used for this purpose.



- 2.3.2.2 - Work positioning system

EN 363 says that a work positioning system is a personal fall protection which enables the user to work supported in tension or suspension in such a way that a free fall is prevented.

- Any suitable body holding device may be used. However, work positioning belts are not recommended.
- Work positioning systems should be adjustable.
- In work positioning systems, the user normally relies on the equipment for support. It is essential, therefore, that special consideration be given to the need to provide a back-up, such as for example, a fall arrest system.



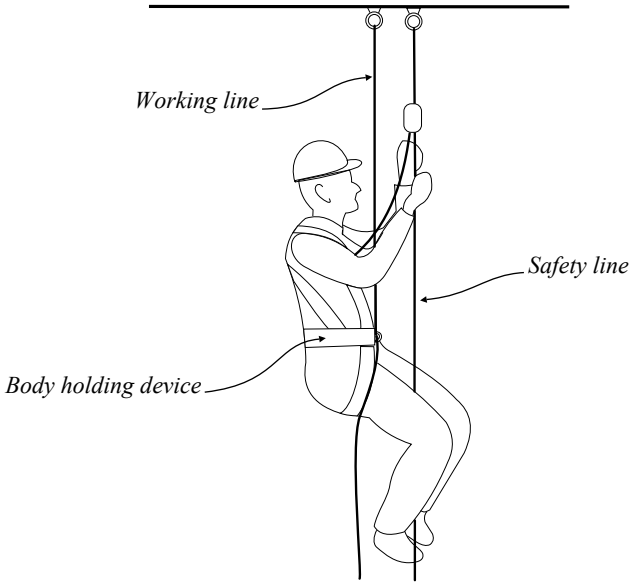
- 2.3.2.3 - Rope access system

Note that rope access operations should be undertaken only by specialists holding a relevant certificate from a recognised organization such as the Industrial Rope Access Trade Association (IRATA).

EN 363 says that a rope access system is a personal fall protection that enables the user to get to and from the workplace in tension or suspension in such a way that a free fall is prevented or arrested.

- The rope access system enables the user to move between higher and lower positions and may allow traversing.
- The working line and the safety line are attached to the same harness.
- The low attachment point on the harness is used for connection to the working line.
- The working line and the safety line are separately attached to the structure.
- A rope access system can be used for work positioning after the workplace has been reached.
- Full body harnesses or sit harnesses can be used.

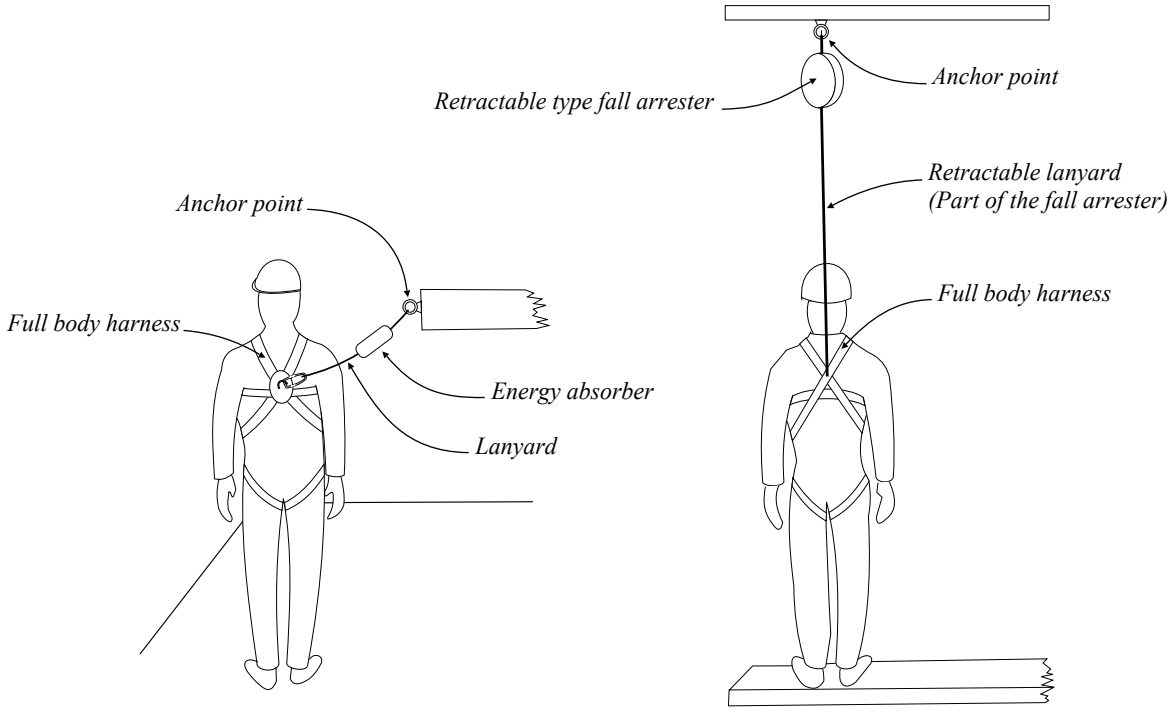
- The possibility of including a seat for comfort and stability should be considered.
- The connection to the user of both the working line and the safety line should always be via the harness, even if a work seat is being used.



- 2.3.2.4 - Fall arrest system

A fall arrest system is a personal fall protection that stops a free fall and limits the impact force resulting from the fall on the user's body. The document EN 363 says the following:

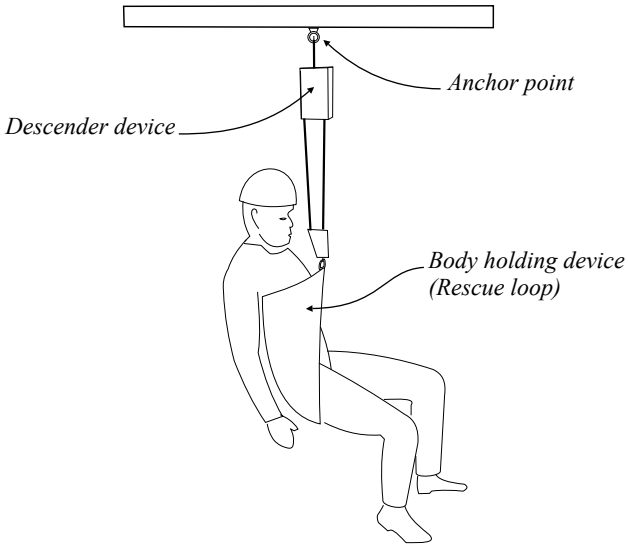
- The system does not prevent a free fall but limits the length of a fall and provides suspension after the fall is arrested.
- The system allows the user to reach areas or positions where the risk of a free fall exists, and when a free fall occurs, it is arrested.
- A fall arrest system must be assembled in such a way that the user’s collision with the ground or structure or other obstacle is prevented.
- The minimum required clearance below the feet of the user must be determined. This may be done based on the information supplied by the manufacturer(s) of the components, in particular taking account of possible interaction with the anchor device (e.g. due to the position and deflection of the anchor device).
- A full body harness must be the only suitable body holding device in a fall arrest system.
- A fall arrest system must include energy absorbing elements or functions to ensure that the impact forces on the body of the user during the arrest of a free fall are restricted to a maximum of 6 kN.



- 2.3.2.5 - Rescue system

A rope access rescue system is a personal fall protection system by which a person can rescue themselves or others and prevent a free fall. EN 363 says the following:

- The system prevents a free fall of both the rescued and the rescuer during the rescue process. It allows lifting or lowering of the rescued to a place of safety.
- An appropriate rescue harness or rescue loop must be used.
- For single use products, a warning must be given that the system must not be used more than once.
- If there is more than one person on the system, the rated load must at least correspond to the total mass of the persons on the system.
- The rescue system should be assembled so that it will not be necessary to cut lines to effect the rescue.
- The system may employ components already used in another personal fall protection system, e.g. a full body harness already worn by the person to be rescued after fall arrest.

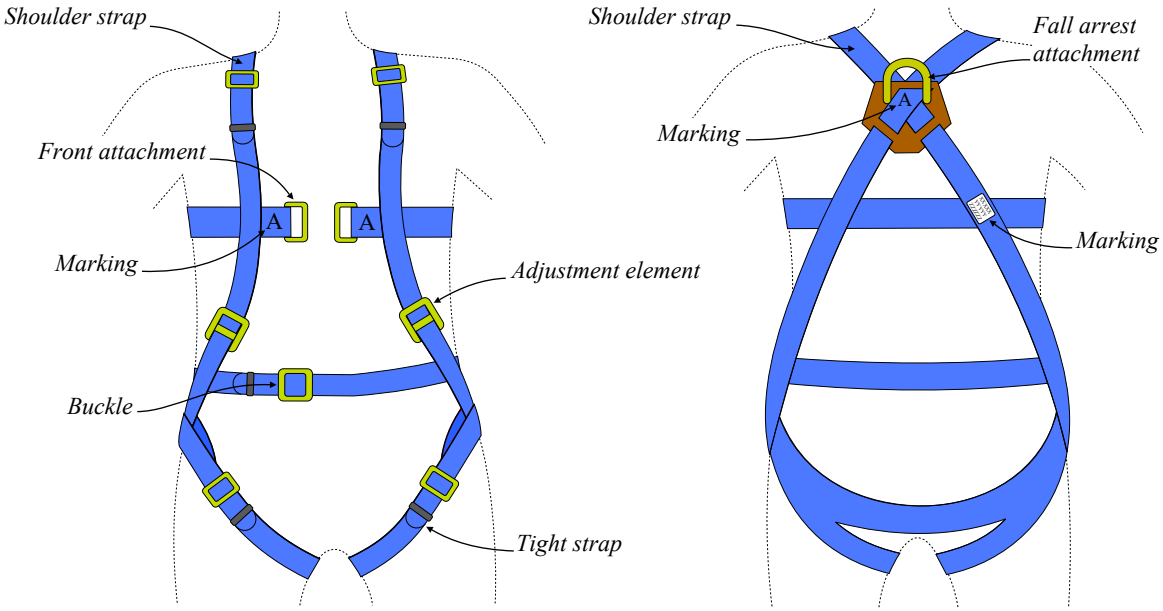


2.3.3 - Specifications of harnesses and fall arresters

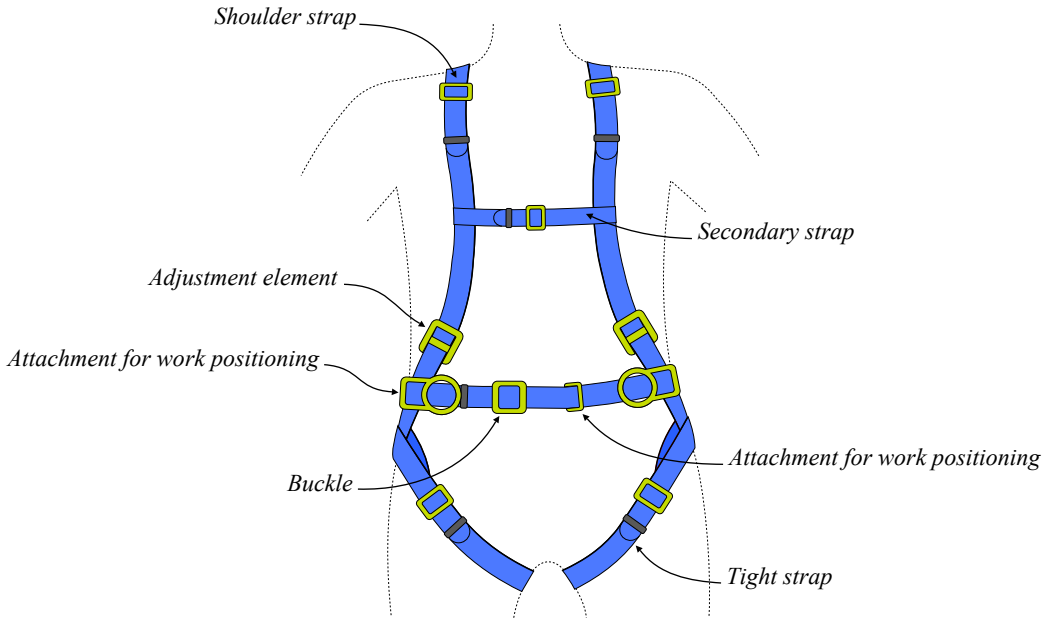
- 2.3.3.1 - Specifications of full body harnesses

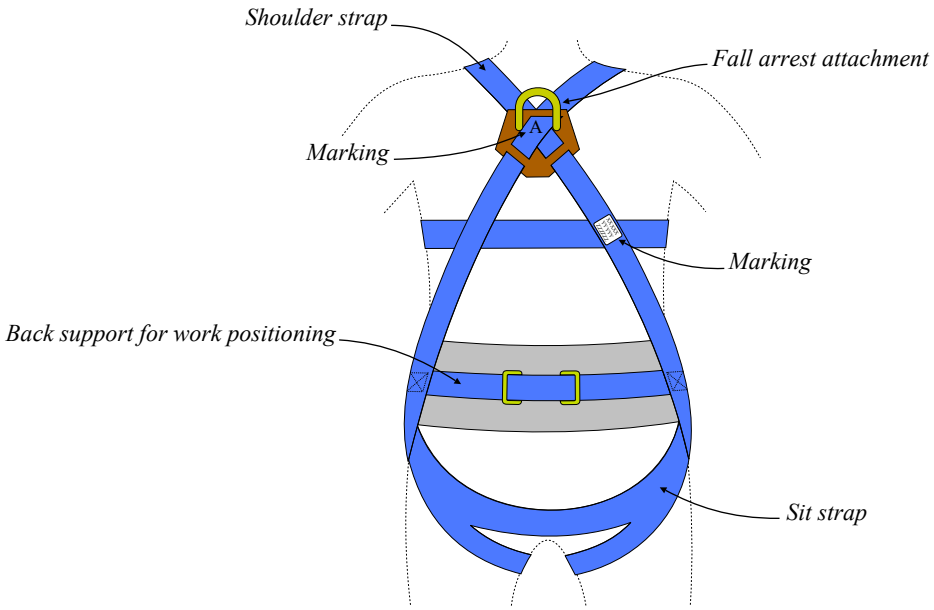
A full-body harness comprises straps, fittings, buckles, or other elements, suitably arranged and assembled to support a person's whole body and restrain the wearer during a fall and after the arrest of a fall. EN 361 says the following regarding its construction:

- The webbing and sewing threads of a full body harness must be made from virgin filament or multi-filament synthetic fibres suitable for their intended use.
- The breaking tenacity of the synthetic fibre must be at least 0,6 N/tex (1 N/tex = 106 Nm/kg).
- Threads used for sewing must be physically compatible with the webbing, and the quality must be compatible to that of the webbing. They must, be of a contrasting shade or colour in order to facilitate visual inspection.
- A full-body harness comprises straps or similar elements placed in the pelvic area and on the shoulders. It must fit the wearer. Means of adjustment are usually provided for this purpose.
- The straps must be designed not to migrate from their position and not be loosen by themselves.
- The width of the straps that support the body must be at least 40 mm, and of the other straps, at least 20 mm.
- A static strength test should be undertaken to confirm that the straps which support the torso or exert pressure on the torso are the primary straps.
- The fall arrest attachment element(s) may be placed so as to lie, during the use of the full-body harness, above the centre of gravity, in front of the chest and/or at the back and/or at both shoulders of the wearer.
- The full body harness may be incorporated within a garment.
- It must be possible to carry out a visual inspection of the whole full body harness, even if the full body harness is incorporated within a garment. All securing buckles (i. e. buckles other than those used primarily for adjustment of fit) must be designed in such a way that they can only be assembled in a correct manner or, if they are capable of being assembled in more than one way, that each method of assembly must conform to the strength and performance requirements.
- Metallic fittings should resist to corrosion. EN 361 says that the requirements should be those specified in the European standard EN 362 (The fitting should work after 24 hours of exposure to a salt spray followed by one hour of drying and an additional salt spray exposure of 24 h).
- Marking on the full body harness must be in the languages of the country of destination. The marking must include the following:
    - A pictogram to indicate that users must read the information supplied by the manufacturer.
    - A capital letter “A” at each fall arrest attachment element;
    - The model/type identification mark of the full body harness, and the name of the manufacturer.
    - The standard used for its construction.
    - The date of production and the date it must be replaced (obsolescence).



Full body harness with front attachment and back attachment for fall arrest





Full body harness with back attachment for fall arrest and attachment for work positioning

- 2.3.3.2 - Specifications of Energy absorbers

An energy absorber is an element or component of a fall arresting system designed to dissipate the kinetic energy developed during a fall from height. It is connected to the full-body harness and the lanyard that is fastened to the structural anchor point. It may be a mechanical system based on friction, compression, or metal bending or be a textile load limiter.

Textile load limiters (also called webbing load limiters) are constructed by connecting webbings with differing techniques:

If strips of webbing are connected using a sewn thread that stitches the webbing together, the device is called a “stitch-ripping device”.

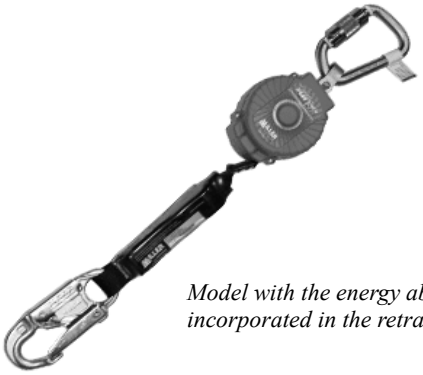
If the mechanism of linking the webbings is interweaving a yarn into the weave, the device is called a “sacrificial tear webbing” or “ply-tear webbing”.

When textile load limiters are activated, the webbing ends are pulled apart, sacrificial elements connecting the webbing are ruptured, limiting the load by the design of these elements.

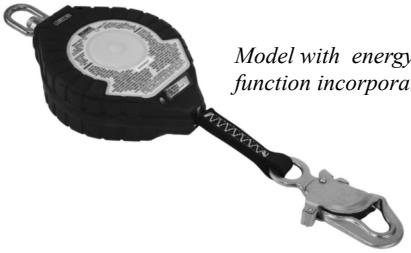
Other systems of mechanical and textile may exist. Energy absorbers must comply with a recognized standard. As an example, the European standard EN 355.

- EN 363 recommends that the manufacturer tests energy absorbers according to the following procedures:
  - When dynamically tested with a rigid steel mass of 100 kg or a torso dummy of 100 kg mass, the braking force must not exceed 6 kN, and the arrest distance H must be $H < 2\,L, + 1{,}75$ m, depending on the total length $L,$ of the energy absorber including the lanyard.
  - When statically tested with a force of 15 kN, the fully developed energy absorber must withstand the static strength test without tearing or rupture.
- Visible marking should be provided on the energy absorber. The following information should be visible:
  - The maximum length allowed of the energy absorber including the lanyard.
  - The model/type identification mark of the energy absorber.
  - The standard the energy absorber conform to (i.e. European standard EN 355 or an equivalent standard).
- In addition to the marking above, EN 355 says that the following information must be provided:
  - The material from which the energy absorber is made.
  - The total length of a sub-system with an energy absorber including lanyard, terminations and connectors must not exceed 2 m (e.g. connector plus lanyard plus energy absorber plus connector).
  - The characteristics required for a reliable anchor point, and how to connect to this anchor point, to a full body harness, and to other components of a fall arrest system.
  - The necessary minimum clearance below the feet of the user, in order to avoid collision with the structure or the ground in case of a fall from the working height. With a mass of 100 kg and a fall factor two situation (worst case) the clearance is the arrest distance H ($H < 2\,L, + 1{,}75$ m, depending on the total length $L,$ of the energy absorber including the lanyard) plus an extra distance of 1 m.
  - How to ensure the compatibility of any components to be used in conjunction with the energy absorber.
  - The hazards that may affect the performance of the material such as the temperature, the effect of sharp edges, chemical reagents, electrical conductivity, cutting, abrasion, UV degradation, and other climatic conditions.
  - That a safe and effective rescue has to be considered prior to starting the operations.

A retractable type fall arrester is a fall arrester with a self-locking function and an automatic tensioning and returning facility for the lanyard. An energy dissipating function may be incorporated in the device itself, or an energy absorber may be included in the retractable lanyard. Retractable type fall arrestor should comply with a recognized standard such as the European standard EN 360.



Model with the energy absorber incorporated in the retractable lanyard



Model with energy dissipating function incorporated in the device

The conception and tests of retractable fall arresters should be done similarly to energy absorbers:

- European standards say that the retractable fall arresters should be designed as follows:
  - A retractable type fall arrester may comprise a drum around which the retractable lanyard reels or unreels, or a return pulley with counterweights. The retractable lanyard can be a wire rope, a webbing or a synthetic fibre rope. The material of a retractable lanyard should conform with a recognized standard such as for example the European standard EN 354. That must be confirmed by the static test carried out by the manufacturer.
  - Energy absorbers not integrated in the retractable lanyard and energy absorbers integrated in the retractable lanyard must conform to a recognised standard (for example, European standard EN 355).
  - The internal end and the external end of the retractable lanyard must be suitably secured to the device.
  - When statically tested, retractable type fall arresters with a retractable lanyard made from synthetic fibre rope or webbing must sustain a force of at least 15 kN. Retractable type fall arresters with a retractable lanyard made from wire rope must sustain a force of at least 12 kN.
  - When dynamically tested with a rigid steel mass of 100 kg, the braking force F_{max} must not exceed 6 kN and the arrest distance *H* must not exceed 2 m.
- As for the energy absorber, the supplier must provide visible marking on the retractable type fall arrester that conforms to a recognised standard similar to EN 365. The following information must be visible:
  - The specific conditions under which a retractable type fall arrester may be used, e.g. vertical, horizontal or inclined.
  - The model/type identification mark of the retractable type fall arrester.
  - The date of production
  - The standard the retractable fall arrester conforms to EN 360 or an equivalent standard.
- In addition to the marking, the following information must be provided:
  - The specific conditions under which the retractable type fall arrester may be used, e. g. vertical, horizontal or inclined.
  - The characteristics required for a reliable anchor point, and how to connect to this anchor point.
  - Components of a complete system must not be substituted.
  - The correct way of operating the retractable type fall arrester.
  - The necessary minimum clearance below the feet of the user in order to avoid collision with the structure or ground in a fall from a height. With a mass of 100 kg the clearance is the arrest distance *H.* This is the vertical distance in metres measured at the mobile load bearing point of the connecting sub-system from the initial position (onset of the free fall) to the final position (equilibrium after the arrest), excluding the displacements of the full body harness and its attachment element, plus an extra distance of 1 m.
  - How to ensure the compatibility of any components to be used in conjunction with the retractable fall arrester.
  - How the performance of the material may be affected by the temperature, the effect of sharp edges, chemical reagents, electrical conductivity, cutting, abrasion, UV degradation, and other climatic conditions.

- 2.3.3.3 - Lanyards

A lanyard is the connecting element or component of a fall arrest system. It may be made of a synthetic fibre rope, a wire rope, a webbing, or a chain. It should be designed according to a recognized standard such as EN 354.



- Both ends of the lanyard must be suitably terminated. When using splices for terminating ropes, the splice must have a minimum length of 100 mm, and it must be secured by whipping or any other method which prevents the splice from coming open in use.
- The length of a non-adjustable or adjustable lanyard, including energy absorber (if applicable) and terminations, such as connectors or eyes, must not exceed 2 m.
- The ends of the adjustment part of the lanyard must be fitted with an end stop.
- Metallic elements of the lanyard except for wire ropes and chains must be protected against corrosion according to a recognized standard such as, for example, the European standard EN 362.

- Fibre ropes, webbing and sewing threads for lanyards must be made from virgin filament or multi-filament synthetic fibres suitable for their intended use.
- Wire ropes for lanyards must be made from steel, the ferrules of termination from a ductile metallic material.
- Wire ropes not made from stainless steel must be galvanized per a recognized process, such as the one explained in ISO 2232, where the dimensional tolerances, the mechanical characteristics, the application conditions, and controls are described.
- Chains must conform to the requirements for at least 6 mm chains given in ISO 1835. Egg-shaped or similar end links and all connecting links must be compatible with the chain.
- When statically tested, lanyards made from textile material or textile lanyard elements, such as synthetic fibre ropes or webbing, including their textile terminations, and if applicable, their adjustment device must sustain a force of at least 22 kN without separating, tearing, or rupture. Lanyards made entirely from a metallic material, including metallic terminations or metallic lanyard elements, for example, connectors or fittings, must sustain a force of at least 15 kN without tearing or rupturing.
- The following information should be marked on the lanyard:
    - The model/type identification mark of the lanyard.
    - The standard used to build the lanyard (EN 354 or an equivalent standard).
- In addition to the marking, the following information must be provided:
    - The total length of a sub-system with a lanyard including an energy absorber, terminations and connectors must not exceed 2 m (e.g. connector plus lanyard plus energy absorber plus connector).
    - The characteristics required for a reliable anchor point, and how to connect to this anchor point.
    - The compatibility of any components to be used in conjunction with the lanyard.
    - The material from which the lanyard is made.
    - The performance of the material may be affected by the temperature, the effect of sharp edges, chemical agents, electrical conductivity, cutting, abrasion, UV degradation, and other climatic conditions.

European standard EN 354 says that a lanyard without an energy absorber must not be used in or as a fall arrest system. Some energy absorbers need a certain distance to stop a fall, and this distance may be too long for works at very small heights. For this reason, self-retracting lifelines are considered preferable when a short fall arrest distance is necessary.

- 2.3.3.4 - Connectors

Connectors are openable devices used to connect components, which enables the user to assemble a system in order to link himself/herself directly or indirectly to an anchor. The standard EN 362 classifies them as follows:

- Basic connector (class B): Self-closing connector intended to be used as a component.


- Multi-use connector (class M): Basic or screw link connector intended to be used as a component, which may be loaded in the major and minor axis.


- Termination connector (class T): designed to allow the fixing as an element of a sub-system in such a way that the loading is in a predetermined direction.

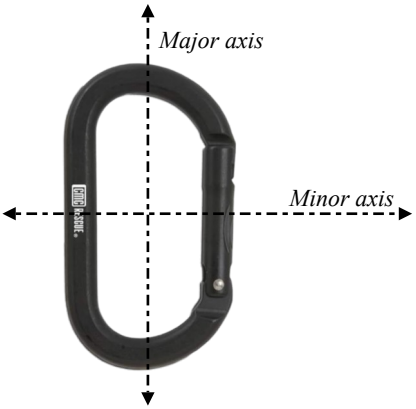

- Anchor connector (class A): Connector which closes automatically, designed to be linked directly to a specific type of anchor as a component.

- Screwlink connector (class Q): Connector which is closed by a screw-motion gate, which is a load bearing part of the connector when fully screwed up, intended to be used only for long-term or permanent connections.

Connectors should be designed according to the following requirements:

- Connectors must not have sharp edges or burrs that may cause injury to the user, or that may cut, rub or otherwise damage webbing or rope.
- Materials, which may come into contact with a user's skin, must not be known to cause irritating and sensitisation effects during normal use of the connector.
- Connectors with a gate must have a gate-locking feature, either automatic or manual:
  - Connectors with a self-locking gate must lock the gate automatically when the gate shuts and must require at least two different deliberate manual actions to open the gate.
  - Connectors with a manual-locking gate, except screw-link connectors, must require a deliberate manual action to lock the gate and require at least two different deliberate manual steps to open the gate.
  - Screw-link connectors must require at least four complete rotations of the screw-motion gate from the fully screwed up position to disengagement of the threads. The threads must not be visible when the gate is locked.
- When tested in accordance with EN 362, connectors must withstand the load specified in the table below for a period of 3 min ± 3 s. At the end of the test, the gate must still be closed.

Description	***Major axis gate closed and unlocked (kN)***	***Major axis gate closed and locked (kN)***	***Minor axis gate closed (kN)***
Basic connector (class B)	*15*	*20*	*7*
Multi-use connector (class M)	*15*	*20*	*15*
Termination connector (class T)	*15*	*20*	*Not applicable*
Anchor connector (class A)	*15*	*20*	*Not applicable*
Screw-link connector (class Q)	*Not applicable*	*25*	*10*



- Connectors with the exception of anchor connectors (class A) must still open after being loaded to 6 kN.
- The marking must include the following:
  - The model/type identification mark of the connector.
  - The standard used to build the connector, and the letter of the class, (as an example EN 362:2004/A).
  - If the minimum strength claimed by the manufacturer for the major axis is marked on the connector, the marking must be for the closed and locked position in accordance with the picture below. The marked strength must be in a whole number of kN.

- In addition to the marking, the following information must be provided :
    - The specific conditions under which the connector may be used.
    - The materials from which the connector is made.
    - The standard used to build the connector, and the letter of the class. (This standard is also marked on the device).
    - The gate opening (in mm).
    - Advice that the length of the connector should be taken into account when used in any fall arrest system, as it will influence the length of a fall.
    - A warning for situations which may reduce the strength of the connector.
- Note that:
    - Connectors with a self-closing and manual-locking gate, should only be used where the user does not have to attach and remove the connector frequently.
    - Care should be taken to avoid loading a connector across its gate.
    - Screw-link connectors (class Q), should only be used where connections are infrequent. They are only safe for use when the screw-motion gate is fully closed.

2.3.4 - Use of personal fall protection systems

2.3.4.1 - Inspect the equipment

It is essential for safety that equipment is withdrawn from use immediately if:

- Any doubt arises about its condition for safe use
- The equipment has been used to arrest a fall and is not confirmed in writing by the competent person that it is still acceptable to do so.
- The equipment has alterations or additions that are not conforming to the recommendation of the manufacturer.
- A repair that has not been carried out by the manufacturer’s procedures.

Harness inspection

- Straps must be checked for frayed edges, broken fibers, pulled stitches, cuts or chemical damage. Special attention should be given to unusual wear, frayed or cut fibers on attachments of buckles and D-rings.
- D-rings and D-ring metal wear pads must be checked for distortion, cracks, breaks, and rough or sharp edges. The D-ring bar should be at a 90 degree angle with the long axis of the belt and should pivot freely.
- When tongue buckles are used, the tongues should be free of sharp edges and distortion in shape and motion. They should overlap the buckle frame and move freely back and forth in their socket. Rollers should turn freely on the frame.
- Friction buckles are often used and must be inspected for distortion: The outer bar or centre bar must be straight. Special attention should be given to corners and attachment points of the centre bar.
- Rivets should be tight and flat against the material. Note that bent rivets will fail under stress.
- Harnesses selected for a particular job must be equipped with all necessary attachment points for fall arresting, work positioning, descent control, rescue, or ladder fall protection.

Lanyard inspection

- The lanyard must be checked for cuts, frayed areas, or unusual wear patterns. Note that spliced ends require particular attention.
- The lanyard should be inspected from one end to the opposite end. During the inspection, it must be slowly rotated so that the entire circumference is checked.

Shock-absorbing and fall arrester devices

- The lanyard has a shock absorber device to limit the arresting forces to 272 kilograms.
- The outer portion of the shock-absorbing pack should be examined for burn holes and tears. Stitching on areas where the pack is sewn to the D-ring, belt or lanyard should be examined for loose strands, rips and deterioration.
- If the device is a fall arrester:
    - The cable/webbing should be fully extended and inspected for damage.
    - The shackle fixing, connecting hook and swaging of cable end and webbing stitching should be inspected.
    - The locking mechanism should be checked by pulling the cable/webbing end sharply and observe whether the cable locks instantly with an audible ‘click’.
    - The fall arrester’s “up” direction must be marked properly so that the equipment can be attached to the line correctly.
    - The locking mechanism that prevents unintentional opening of the device and subsequent disengagement from the lifeline must be inspected as well.

Connectors (Snap hooks / Carabineers)

- Only double locking connectors should be used

- Connectors should be inspected regularly for stress, wear, distortion, and spring failure
- The gate must open and close quickly and easily. The opening must be sufficient to allow easy connection.
- For a connector that is incorporated into another component such as a lanyard, an energy absorber or a fall arrester, the information supplied by the manufacturer of the connector must be adopted. The strength of the connector must conform to the strength requested for the component it is incorporated with.

Horizontal life lines

- Aluminum is not permitted for horizontal lifelines because it wears excessively.
- Horizontal lifeline system should be designed and approved by a competent person. Note that the anchorages to which the lifeline is attached must be designed for this purpose.
- The maximum number of workers the lifeline can withstand must be indicated.
- The rope or cable have the required initial sag. It must be free from signs of wear and abrasion. (The procedure of inspection should be as for a lanyard).

- 2.3.4.2 - Use the equipment

Note the following:

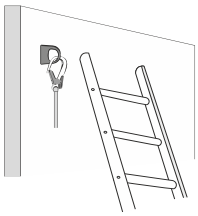
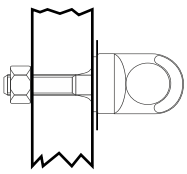
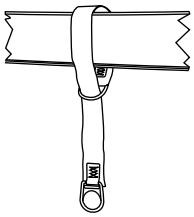
- The equipment must not be used outside its limitations, or for any purpose other than that for which it is intended.
- Methods to retrieve fallen workers must be in place.

Workers must be instructed in the use and care of harnesses and shock absorbing devices.

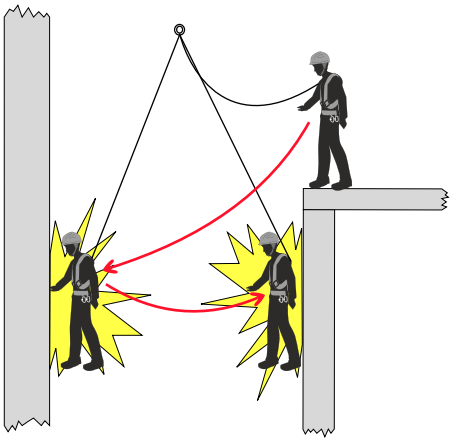
- The snap hook should be attached to the D-ring, eyebolt, or other hardware in the manner approved by the manufacturer.
- The lanyard length including the energy dissipating element and connectors should be as short as necessary and in no case greater than 2 m (EN 354). Manually adjustable lanyards should be used when it is desirable to be able to take slack out of the lanyard. Note that knots are prohibited on lanyards.
- The fall arrester must be compatible with the lifeline on which it is installed.

Anchorage points

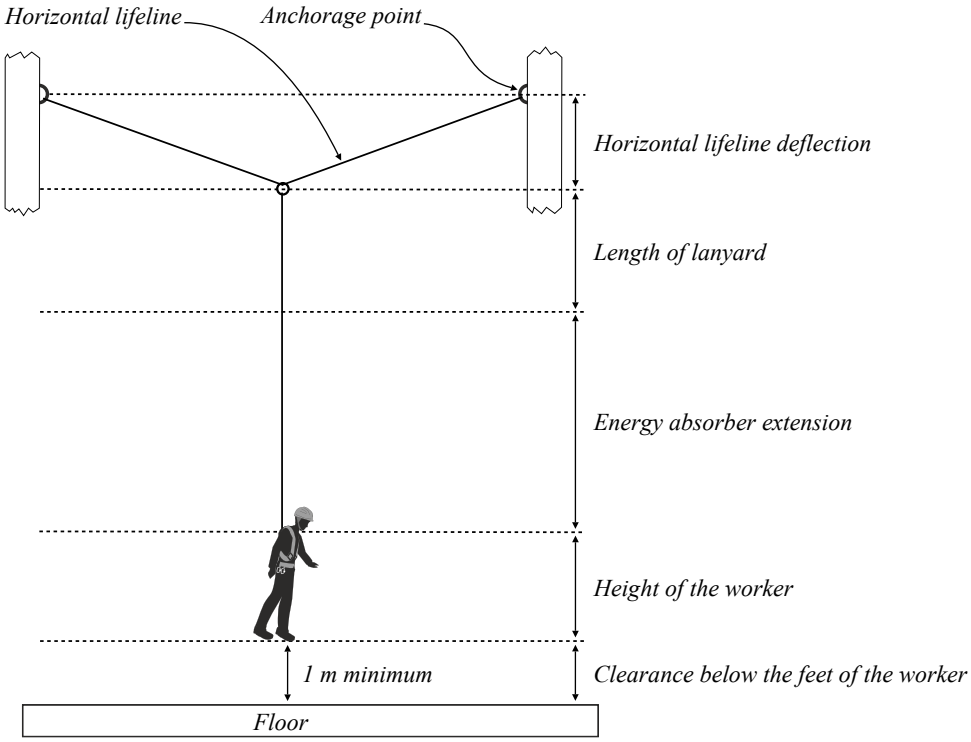
- The workers must know the appropriate anchorage points for each task that requires a fall-arrest or restraint system. Anchorage points must be stable, substantial, and have sufficient strength to withstand twice the potential impact energy of the free-fall. The personal fall prevention system may be attached to one of the following:
  - Permanent suitable features of the vessel or the structure (e.g., a welded eyebolt or a drilled hole in a steel beam).
  - An anchor device that is specifically design-made (e.g., an eyebolt installed permanently or temporarily to a structure).
  - A feature of the building or structure (e.g., a structural column or beam of which a lanyard, or anchor sling can be placed around).

- Arrangements must be in place to allow horizontal and vertical moves from one station to another without exposure to a fall.
- The anchor point must be always positioned to minimise both the potential for falls and potential fall distance. It also should be positioned to avoid swinging in the case of a fall. To minimize the pendulum effect, workers should keep the line perpendicular to the anchor point.



- When anchorage points have been added, a test certificate that conforms to the European standard EN 795 or an equivalent standard must be provided by the installer prior to using them.
- When using fall arrest systems, it is essential for safety to verify the free space required beneath the user at the workplace before each occasion of use, so that, in the case of a fall, there will be no collision with the ground or other obstacle in the fall path.
    - The total length of a sub-system with an energy absorber including lanyard, terminations and connectors must not exceed 2 m (e.g. connector plus lanyard plus energy absorber plus connector).
    - The necessary minimum clearance below the feet of the user, in order to avoid collision with the structure or ground is the vertical distance in metres, measured at the mobile load bearing point of the connecting sub-system from the initial position (onset of the free fall) to the final position (equilibrium after the arrest), excluding the displacements of the full body harness and its attachment element plus an extra distance of 1 m (see picture below).



2.3.5 - Maintenance of equipment

The maintenance instructions of the equipment supplied by the manufacturer must be clear, legible and unambiguous, and must contain appropriate detail, supplemented by diagrams if necessary, to enable the equipment to be maintained correctly and safely. The maintenance instructions must include:

- Cleaning procedures, including disinfection where applicable, without causing adverse effect on the materials used in the manufacture of the equipment, or to the user, and a warning that the procedure is to be strictly adhered to.
- Where appropriate, a warning that when the equipment becomes wet, either from being in use or when due to cleaning, it must be allowed to dry naturally, and must be kept away from direct heat.
- Storage procedures, including all necessary preventative requirements where environmental or other factors could affect the condition of components.
- Other maintenance procedures as relevant to the equipment, as an example, lubrication.

Manufacturers must provide all the necessary information and equipment to enable periodic examinations such as instructions, checklists, spare parts lists and special tools etc. Instructions for periodic examination must include:

- Recommendation in regard to the frequency of periodic examinations taking account of such factors as legislation, equipment type, frequency of use, and environmental conditions. Note that the periodic examination frequency must be at least every 12 months. Also, note that the periodic examinations are only to be conducted by a competent person for periodic examination and strictly in accordance with the manufacturer's periodic examination procedures.
- Where deemed necessary by the manufacturer, (due to the complexity or innovation of the equipment), or where safety critical knowledge is needed in the dismantling, reassembly, or assessment of the equipment, (as an example, a retractable type fall arrester), periodic examinations must only be conducted by the manufacturer or by a person or organisation authorised by the manufacturer.
- Requirement to check the legibility of the product markings.

Repair must only be conducted by a competent person who has been authorised by the manufacturer, and the repair procedure must be strictly in accordance with the manufacturer's instructions.

The record of maintenance should contain the following details:

- Product, model and type/identification and its trade name.
- Name and contact details of the manufacturer or supplier.
- Means of identification, which could be the batch or serial number.
- Where applicable, the year of manufacture or life expiry date.
- Date of purchase.
- Any other information as necessary, e.g. maintenance and frequency of use.
- Date first put into use.
- History of periodic examinations and repairs, to include:
    - Dates and details of each periodic examination and repair, and the name and signature of the competent person who carried out the periodic examination or repair.
    - Next due date for periodic examination.

3 - Preparation for mobilization and maintenance.

3.1 - Mobilization

Works at height are usually performed during the mobilization of portable diving and ROV systems on vessels of opportunity. They should be planned with the mobilization plan.

1. The deck plan that shows the various parts of the system to be installed should be studied.
    - The parts of the system that need to be installed at height should be identified.
    - The electrical supply lines and gas line to install at height should also be identified.
    - The possibility not to perform works at height should be evaluated and should be the preferred solution. That includes using extendable tools from ground level to remove the need to climb a ladder or installing cables at ground level if suitable protections are available.
2. When the elements that need work at height to be installed are identified, the means of access should be selected.
    - A risk assessment should be done for each component to install that compares the means of access available with their advantage and inconvenience. That takes into account the space occupied by these devices, their ease of transportation and implementation, the stability of the vessel, and whether the mobilization is completed in port alongside the jetty or in the harbour where the ship is more exposed to bad weather conditions.
    - The risk assessment should consider the existing anchor points and those that are to be installed. When additional anchor points are to be installed, the procedure for how they can be safely installed should be considered.
    - When the means of access are identified, they should be listed for each element to install.
3. The supply of the selected means of access should be then evaluated:
    - The phases of the mobilization plan should be scheduled to identify the devices that can be shared between teams and when these devices are to be provided.
    - Existing devices should be checked for their condition and conformance to the applied standards.
    - Incorrect devices should be removed from the worksite to avoid the teams the temptation of using them.
    - Missing equipment should be provided. The guidelines indicated in this study should be used to ensure that they conform to recommended standards.
4. The teams in charge of the mobilization should be organized:
    - People authorized to work at height should be identified with the means of access they are allowed to use.
    - Supervisors should be aware of the several phases of the mobilization plan and when the necessary means of access will be available.
    - Toolbox talks should be organized every day where the risk assessment for the planned tasks is discussed. The management of the change system should be in place.
    - The person in charge of the entire mobilization process should be identified. He must be aware of the various works at height and ensure that relevant procedures are in place.

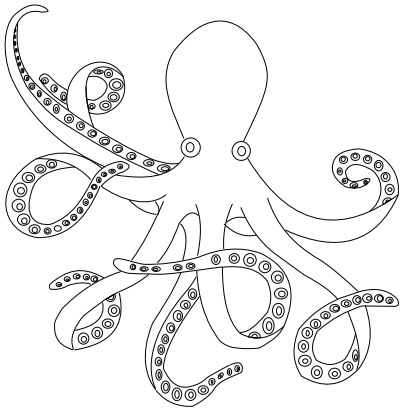
3.2 - Maintenance

When the mobilization is completed, the necessary devices for maintaining the various parts of the diving or ROV system situated at height must be kept or created. If the Diving and ROV systems are built-in, these means of access should be provided if they are not in place or damaged.

1. As for the mobilization plan, the parts of the system that require interventions at height for their maintenance should be identified and logged.

2. Elements that need to be frequently inspected and maintained should be provided with permanent means of access when it is possible. It is, for example, the case for winches and umbilicals' reels. Guards, welded ladders, horizontal lifelines, and stairs are commonly installed for this purpose.

3. When permanent means of access cannot be installed to access the high parts of the system, devices such as ladders, small scaffolds, ascent ropes, lanyards, energy absorbers, harnesses, and others should be selected and provided. They should be chosen using the same procedures as for the mobilization. Also, they should be kept available at all times and adequately stored. In addition, permanent anchorage points should be installed on the system to secure them when they have to be used.
4. Equipment for working at height should be logged in the store as the other tools and changed when damaged, or the date for replacement is reached.
5. The maintenance of diving and ROV systems is a routine task that the technicians in charge perform. For this reason, they must be familiar with work-at-height procedures. The supervisors should ensure that the technicians under their responsibility are competent in using the work-at-height devices they implement.



CCO Ltd

Email: info@ccoltd.co.th
Tel: +66 857 277 123
Website: http://www.ccoltd.co.th/