



ProGuide Series



100%
WATERPROOF
PAPER



UK EDITION

ROPE ACCESS AND RESCUE

ISO 22846 — BS 7985

Dr DF Merchant

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Rope Access & Rescue

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LIFTING OPERATIONS AND LIFTING EQUIPMENT REGULATIONS



Applies to the *planned* lifting or lowering of any load, including persons.

Examples of lifting operations

- ✓ Jacking a vehicle.
- ✓ Raising/lowering any item by winch or crane.
- ✓ **Rope access and rescue** where a person is suspended.
- ✓ Hand-hauling tools with a bucket and rope.

Examples of exempt (non-lifting) tasks

- ⚠ Towing vehicles and trailers.
- ⚠ Drawing cables through horizontal ducts or trenches.
- ⚠ **Fall arrest and work restraint.**
- ⚠ Manual handling tasks, carrying items on belts, etc.

Lifting "Equipment"

All work equipment for lifting or lowering loads, including its attachments used for anchoring, fixing or supporting it.

Lifting "Accessories"

The subset of Lifting Equipment for attaching loads to machinery for lifting, e.g. shackles, slings, ropes, harnesses, etc.



Rope Access & Rescue

LOLER REQUIRES THAT

- ✓ Lifting equipment is of adequate strength and stability.
- ✓ All work is planned by a competent person, appropriately supervised and carried out in a safe manner.
- ✓ The risks of any item striking a person, or a load drifting or falling freely, are as low as is reasonably practicable.
- ✓ All lifting equipment is marked with its safe working load.
- ✓ All lifting equipment is Thoroughly Examined at regular intervals and reports made and kept.



The L113 Approved Code of Practice further expands on these core legal duties.

- i** The Provision and Use of Work Equipment Regulations (PUWER) also apply, which have general duties such as providing training to users, complying with instructions, storing safely, fitting guards on moving parts, etc.
- i** *Some* lifting equipment used for work at height will also be classed as Personal Protective Equipment.
- i** LOLER applies equally to planned lifting in an emergency, e.g. casualty rescue or abseil evacuations.

Personal Protective Equipment has a strict definition in UK/EU law:



- (a) Equipment designed and manufactured to be worn or held by a person for protection against one or more risks to that person's health or safety;
- (b) Interchangeable components for equipment in point (a);
- (c) Connexion systems for equipment in point (a) that are not held or worn by a person, that are designed to connect that equipment to an external device or to a reliable anchorage point, that are not designed to be permanently fixed and that do not require fastening works before use.

Clause (c) covers equipment such as the ropes and karabiners used in rope access which are not "worn or carried", but which connect the user to the anchor points.

The following are **not** PPE:

- ⚠ Installed anchor systems, cranes, ladders, scaffolding, etc.
- ⚠ Items designed for use **by more than one person**.
- ⚠ Emergency equipment, e.g. stretchers or first aid kits.



All UK PPE **must** have the UK/CE Marking.



Category III PPE, including fall protection equipment, must be certified by an official test lab and their code number must always appear next to the UK/CE Marking.



FRAGILE SURFACES**AVOID ALL UNNECESSARY ACCESS ONTO FRAGILE SURFACES**

The risk is not simply hitting the ground, but also from passing through sharp edges and of broken material falling onto others.

- ✓ Consider all non-contact methods first (elevated platforms, scaffolding, long-reach tools, drones and pole cameras).
 - ✓ All persons within ~2m of a fragile surface must use PFPE (operating in restraint wherever possible).
 - ✓ Use load-spreading walkways using ply sheets or planks.
 - ✓ If risk remains, consider netting/sheeting over the surface, airbags underneath, or PFPE with overhead anchor lines.
- ⚠ **Only deploy fall arrest PFPE as a last resort.**
- ✓ Lanyards can be severed by sharp edges of a hole.
 - ✓ Rescue is difficult (e.g. two people overloading surfaces).



Fragile rooftop areas (skylights etc.) can be hidden by later re-surfacing. Never trust what you can see, always check the plans!



Rope Access & Rescue

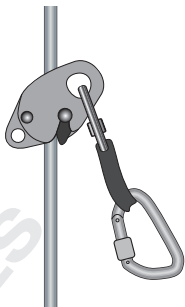
- ✓ Primary support is via the **ventral** attachment point (AP).
- ✓ Descender, cowstails, chest and foot ascender are connected in sequence from right to left.
- ✓ Foot ascender is connected by accessory cord or webbing (to prevent loss, not to arrest falls).
- ✓ Étrier or foot loop (not PPE) attached to foot ascender.
- ✓ Mobile fall arrester connected to **dorsal** AP (using rope/webbing or energy absorber as per product instructions).
- ✓ Spare/emergency gear carried on racking; at a minimum:
 - ✓ Spare locking karabiners.
 - ✓ Pulley (may be integrated into a karabiner).
 - ✓ Safety-blade knife or cutting tool.
 - ✓ Two anchor slings, 100cm or longer.
 - ✓ Short (10cm) sling for rescues.
- ✓ Working inverted is permitted.
- ✓ For prolonged suspension, work seats must be used. Descender is connected to the SEAT, and the ventral AP is also linked to the same karabiner. Seats are not PPE so can be home-made.



BACKUP DEVICES (MOBILE FALL ARRESTERS)

These move freely along a vertical or inclined rope, but lock automatically when a sudden force is applied. **Some** designs can be used as belay devices.

Unless otherwise marked they are single-user and great care must be taken during rescues.



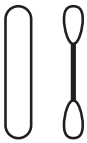


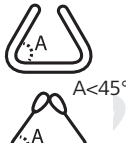

For rope access they are used with EN 1891 low-stretch rope ONLY.

- ✓ Only work in one direction - always check before use.
- ✓ Should comply with EN 12841 or EN 353-2.
- ✓ Keep as high as possible - avoid any slack rope.
- ⚠ Follow product instructions as to length of lanyard/cowstail.
- ⚠ Some devices require a lanyard with an energy absorber.
- ⚠ Some devices do not work on heavily-tensioned rope.
- ⚠ Always connect to the harness fall arrest (A) anchor points.
- ⚠ Avoid falls when the device is close above a knot.
- ⚠ Slow falls (e.g. slips on hillsides) may not lock the device.



Rope Access & Rescue

MODE FACTORS FOR ANCHOR SLINGS

 1.0 End to end	 2.0 Doubled	 0.8 Choked	 1.4 Basket	 1.0 Round lift
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The safe working load of a sling is given by the mode factor multiplied by the working load limit (WLL).



PPE sling labels show the MBS and you must apply a 7:1 safety factor to get the WLL.

LEG MULTIPLIERS (LEG ANGLE $A < 45^\circ$)



× 1.4



× 2.1



× 2.1

e.g. A 3-leg bridle of choked slings, each marked "MBS 22kN"

$$\text{Bridle SWL} = (2200 \div 7) \times 0.8 \times 2.1 = 528\text{kg}$$

PULLEYS

- ⚠ For work at height and rescue, always use PPE pulleys to EN 12278.
- ✓ Swingcheek designs are the most versatile.
- ✓ Twin pulleys used in hauling and rescue should have a lower “becket” hole, as shown above.
- ✓ Some karabiners have a pulley sheave in the body casting, but forcing a rope into a tight radius turn reduces strength, and they often have inferior bearings (or none at all).



EN 12278 pulleys are designed for use with climbing rope and have an MBS of at least 15kN (SWL 375 kg with a 4× FoS). For heavier loads or thicker ropes, use **certified** EN 13157 lifting pulleys; which are available in any size and load rating.

SWIVELS

- ✓ Useful in rescue to allow stretchers to rotate and to prevent pulley systems from twisting.
- ✓ There is no EN standard for a swivel so they are approved under the EN 354 lanyard standard.



Rope Access & Rescue

There are contradicting standards, so helmets should be chosen carefully. **EN 14052** is advised for rope access & rescue.

EN397 — Industrial helmets for ground-level use

- ✓ Optional, intentionally weak chinstrap.
 - ⚠ Not likely to remain in place during a fall.
- ⚠ Protection only for vertical impacts.
- ✓ Ventilation slots optional (must have shutters).
- ✓ Flame resistant.
- ✓ Optionally tested with molten metal splash / electricity.

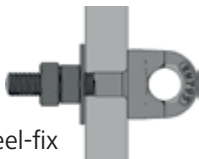
EN12492 — mountaineering helmets

- ✓ Mandatory and strong chinstrap and Y-cradle.
 - ❗ On ground level worksites, UNFASTEN the chinstrap.
- ✓ Better protection for side impacts.
- ✓ Must have ventilation slots.
- ⚠ No protection against flame, heat, electricity.

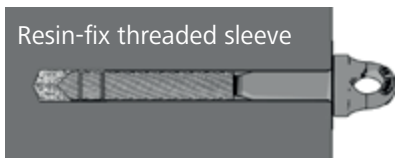
EN14052 — high performance helmets

- ✓ Mandatory and strong chinstrap and Y-cradle.
 - ❗ On ground level worksites, UNFASTEN the chinstrap.
- ✓ Maximum impact protection from all directions.
- ✓ Resistant to flame, heat, molten metal splash and electricity.
- ✓ Ventilation NOT permitted.

PFPE EYEBOLT ANCHORS



Steel-fix



Resin-fix threaded sleeve

- ✓ Should comply with EN 795 Type A, and CEN/TS 16415 when rated for more than one-person loads.
- ❗ Not legally PPE so no UK/CE Marking.
- ✓ Rated MBS >12kN. (SWL into masonry ≈100kg).
- ✓ EN 795 requires the anchor device be removable.
- ✓ EN 17235 covers permanently-fixed anchor devices.
- ✓ BS 8610 is a **UK-only** standard for anchor devices that expands the testing and marking requirements in EN 795.
- ⚠ EN 959 sport climbing anchors must not be used for work.
- ✓ Formal inspection at least annually (6 monthly for LOLER).
 - ✓ Pull tested applied after fitting and at each inspection.
- ⚠ **Never use an out-of-date eyebolt.**
- ⚠ Don't rely on the label – there may be recent damage.
- ✓ Inspect surrounding structure for cracks, etc.
- ✓ Use a karabiner, do not tie directly to the eye.

BARREL KNOT



Approx strength 75% of rope. Used to form slippery loop at the end of a line – will contract to grip very firmly. Difficult to release after heavy loading. Adding a third turn has minimal benefit and makes release almost impossible.

- ✓ More compact than “Figure” style knots.
- ✓ Stronger in dynamic loads - ideal for cowstails.



Tied identically to one half of a double fisherman's bend, but starting with a bight of rope.



Always tighten the loop. This is not a rope adjuster!

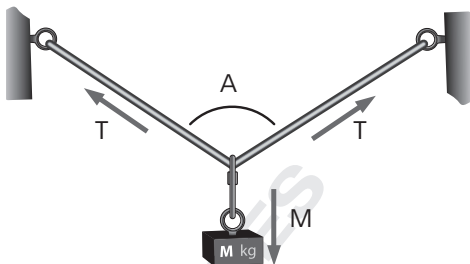


⚠ **Do not load the short tail.**



BRIDLE LOAD VS. ANGLE OF SPAN

For a load **M** and an equal bridle angle **A**, the line tension **T** equals **M** multiplied by the bridle factor **B**:-



$$T = M \times B$$

Angle A	0°	60°	90°	120°	150°
Bridle factor B	0.5	0.58	0.7	1	2

e.g. if $A=90^\circ$ and $M=100\text{kg}$, the rope tension $T = 70\text{kg}$



Aim to keep the bridle angle **A below 90°, and never exceed 120°.**

If the bridle legs are not at equal angles, use the force triangle method from page 64.

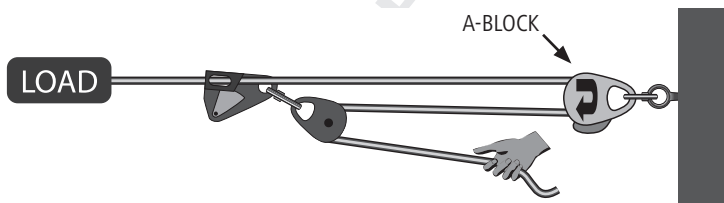


COMPOUND PULLEY SYSTEMS

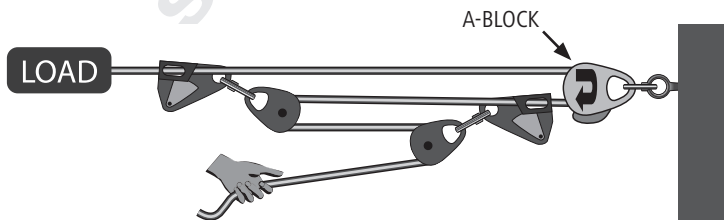


Uses a set-reset action – slower on long lifts.
Larger minimum length when fully collapsed.
Requires rope clamps and one-way pulleys.
Uses less rope than a block and tackle.
Load is free to rotate.

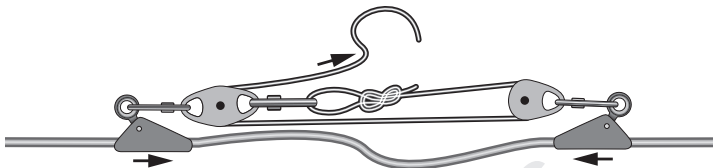
Z-RIG - 3:1 ADVANTAGE



W-RIG - 5:1 ADVANTAGE



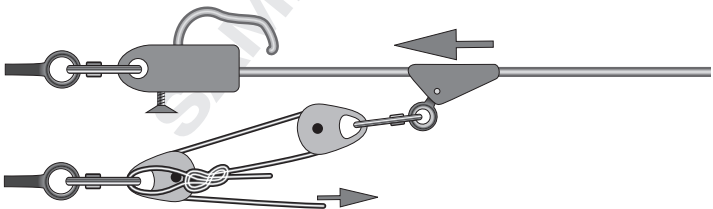
JIGGERS



Self-contained pulley system to apply tension or assist hauling. Uses opposing rope clamps to connect to main lines. Can be pre-assembled from accessory cord. A ratchet pulley allows the jigger to retain tension but is not usually required. Often used to form slack so a descender etc. can be attached to a rope.

Example: friction-free hauling

The jigger draws in the rope, allowing it to pass easily through the descender, which holds the tension as the jigger is reset.

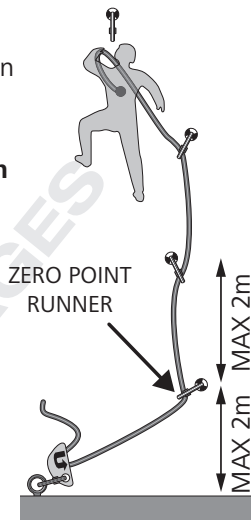


Rope Access & Rescue

LEAD CLIMBING

This is a **fall arrest** task. Fall distances can be very significant. **Use EN 892 rope.**

- ✓ **Belaying with EN 1891 low-stretch rope is safe only if the fall factor stays below 1 at all times.**
- ✓ Running anchor points should be installed at approx 2m intervals.
- ✓ The “zero point” runner must be installed before climbing commences.
- ✓ The rope must be controlled by an automatic belay device which is anchored to a fixed object – **not to a person.**
- ✓ Locking karabiners must be used throughout.
- ✓ Friction at the runners aids in fall arrest, do not use pulleys!
- ✓ Using one single ① rope or two half ½ ropes.
- ✓ Do NOT use twin ② rope.



ROPE-ROPE CHANGEOVER, ALONE

Maintaining ***at least two*** points of contact is crucial:

IN DESCENT:-

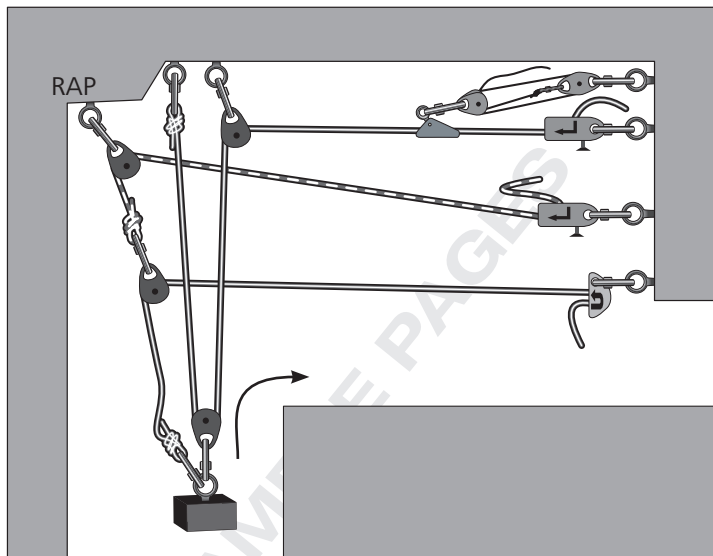
- ✓ Place new MAIN rope into chest ascender.
- ✓ Place foot ascender onto new MAIN rope.
- ✓ Transfer backup device to new BACKUP rope.
- ✓ Release descender until weight held by new MAIN rope.
- ✓ Transfer descender to new MAIN rope, close under chest ascender, and lock it off.
- ✓ Stand in footloop, remove chest ascender, sit down.
- ✓ Remove footloop and continue descent.

IN ASCENT:-

- ✓ Place descender on old MAIN rope, close under chest ascender, and lock it off.
- ✓ Stand in footloop, remove old rope from chest ascender and insert new MAIN rope. Pull slack rope through.
- ✓ Sit onto new MAIN rope and/or old MAIN rope.
- ✓ Transfer foot ascender onto new MAIN rope.
- ✓ Ascend until both MAIN ropes are under some load.
- ✓ Transfer backup device to new BACKUP rope.
- ✓ Remove descender and continue ascent.



Rope Access & Rescue



A deep V system using a 2:1 main rope to assist in lifting. Backup uses the RAP system as before.

On arrival at the landing place, the RAP (dashed rope) is released and the backup rope used to draw the load away from the edge as the main rope is slowly paid out.

OWN-ROPE RESCUE FROM BELOW

To rescue a rope access worker by climbing their own rope(s), using only yours and their personal rope access equipment, it is important to reverse the main and backup rope allocations.



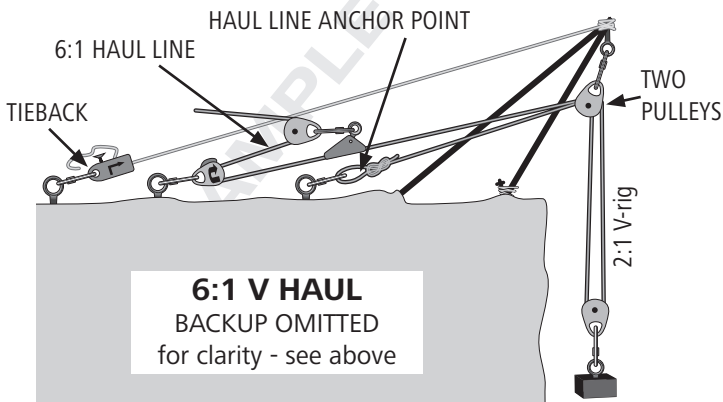
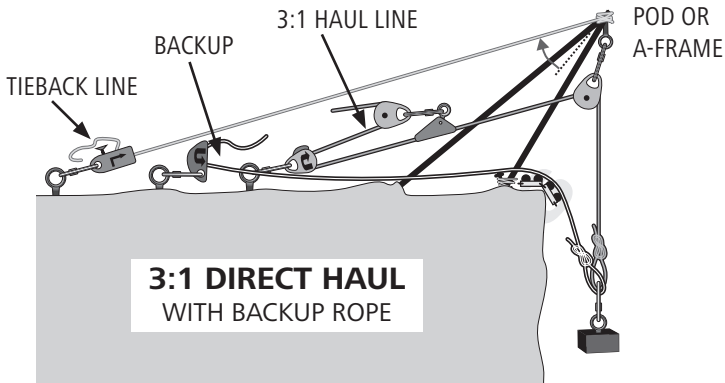
If the casualty is using a single rope, pass them as if they are a knot (see page 80) but use extreme caution.

CASUALTY STRANDED ON A DESCENDER

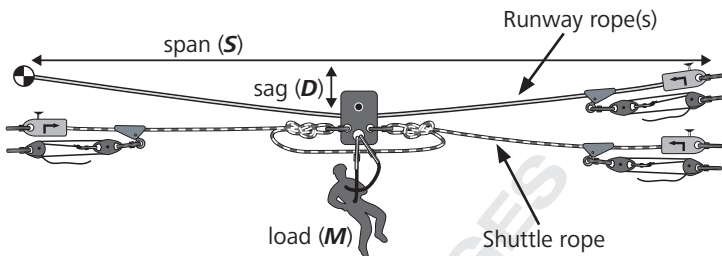
1. Connect your backup device to the casualty's MAIN rope.
2. Connect your chest/foot ascenders to their BACKUP rope.
3. Climb to the casualty and clip a cowstail to their harness.
4. Transfer your backup device above the casualty.
5. Remove their backup device entirely.
6. Ascend above them as far as your cowstail will allow.
7. Change into descent mode and abseil level with them.
8. Clip a short link between your descender and their chest fall arrest point (or the top hole of their chest ascender).
9. Lower tension from their descender and remove it.
10. Abseil to ground, using extra friction as required.



LEADING EDGES



HIGHLINE TRAVERSE (SIMPLE RIG)



Highlines are formed from tensioned (approximately) horizontal "runway" ropes, along which a "carriage" pulley travels, supporting the load. The position of the carriage is controlled by one or two "shuttle" lines, as necessary.

Two runway ropes are used, with a large-bore highline pulley (as above) or a pair of singles and linked backup pulley (below).

Runway line anchor loads (F) can be extremely high

F is approximately equal to
$$\frac{(\text{load } M) \times (\text{span } S)}{2 \times (\text{sag } D)}$$

e.g. $M = 200\text{kg}$, $S = 50\text{m}$, $D^* = 3\text{m}$; anchor load $F = 1670\text{kg}$

* sag (D) is measured at the middle of the span when under full load.

