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References

1 Legal

Bungee jump operators have duties principally under the following health & safety legislation:

- Health and Safety at Work etc. Act 1974
- Management of Health & Safety at Work Regulations 1999
- Work at Height Regulations 2005 (as amended)
- Lifting Operations and Lifting Equipment Regulations 1998
- Provision and Use of Work Equipment Regulations 1998
- Personal Protective Equipment at Work Regulations 1992

Operators are responsible for taking the right precautions to reduce the risks of harm to their workers, bungee jumpers and other persons such as spectators.

In the past, a code of practice was produced by the British Elastic Rope Sports Association (BERSA). BERSA is no longer active and there is no industry body representing bungee jumping operators in the UK. There are no British or European standards for safe operation of bungee jumps

This document, which has been drafted in consultation with the UK's largest bungee jump operator, incorporates industry good practice. It outlines some actions which may go beyond the minimum required to comply with health and safety law, but which the industry agree are key to ensuring the safety of staff, jumpers and spectators. It does not provide detailed technical information on setting up and managing bungee jump operations.

Where referring to actions to be taken by the operator:

- **'must'** is used to indicate an explicit legal requirement to take a certain action;
- **"should"** is used to indicate what to do to comply with the law – although duty-holders are free to take other action if that would result in compliance.

- **'recommend'** indicates that the advice goes beyond the minimum required to comply with the law..

2 Background

2.1 *Description of activity*

A few specialised operators offer bungee jumping in the UK. Jump sites range from indoor and outdoor fixed sites (over land or water), to mobile sites where the jump takes place from cranes.

HSE does not discourage members of the public from participating in challenging and exhilarating leisure activities however, those providing such activities should take sensible and proportionate measures to manage unacceptable risk.

There are of course residual intrinsic risks associated with all extreme sports. Bungee jumpers are accepting these residual risks to experience the exhilaration of an extreme sport.

2.2 *What could go wrong*

The nature of the activity means that the potential consequences of a failure of equipment or human or procedural error during the jump will have serious consequences for the jumper and potentially others.

Table 1 lists some potential failures that alone or in combination could result in fatal or major injuries, broadly classified as equipment or human error / procedural failures.

Table 1 Potential failure modes

Equipment	Human / Procedural
failure (breaking) of the mechanism attaching the bungee to the anchor point	failure to attach the bungee to the anchor point
failure (breaking) of the bungee	failure to attach the bungee to the jumper
failure (breaking) of the mechanism attaching the bungee to the jumper	selection of a bungee with the wrong characteristics for a given jumper
failure of body harness or ankle cuffs	jumper striking against another object during rebound (crane jib, bridge etc.)
failure of jump platform (e.g. collapse of floor or barrier etc.)	non-jumper (employee or spectator) falling or being pulled from the jump platform
failure of crane (if used)	spectator hit by jumper or object falling from a platform
failure or error during retrieval (various possible modes, including risk to staff undertaking retrieval)	

2.3 Fundamental principles

Industry good practice is based on the fundamental principles of redundancy, integrity, inspection, competence of personnel and informed participation. A competent operator should be aware of these principles and be able to demonstrate their application. For example:

- **Redundancy** can be built in by the duplication of safety critical equipment, i.e. bungee attachment points to the ankle cuff and body harness, by double checking of safety critical actions, i.e. weighing of the jumper twice, on two different sets of scales by two different competent persons; and by increasing safety factors against equipment failure i.e. de-rating the safe working load of the crane and associated lifting equipment.
- **Integrity** of safety critical equipment can be assured by selection and maintenance of equipment that meets recognised standards, for example steel karabiners manufactured to BS EN 362:2004 and by dead weight drop testing.
- **Inspection** of safety critical equipment must be carried out at suitable, regular intervals.
- **Competence** of workers in their assigned tasks. Workers must be trained to carry out their tasks and it is recommended that records of training are

kept. Understanding of and adherence to operating procedures must be monitored to minimise human error.

- **Informed Participation.** Jumpers should be made aware of the risks involved and given the choice whether to take part or not.

3 Equipment

3.1 Ropes, harnesses and connectors

3.1.1 Selection

Bungee rope

The bungee rope used is critical to the safety of the activity and must be matched to the weight of the jumper and the height of the platform. There are two main categories of bungee rope, braided and un-braided.

Braided ropes are commercially available, manufactured to BS 3F 70 1991. Un-braided ropes are custom made for bungee jumping and are not covered by a standard. Further detail and photographs are given in Annex 1.

Operators should understand the characteristics of the rope they have selected. Operators must ensure that bungee ropes are clearly identifiable according to their rating for jumper weight to help minimise human error. Colour coding is recommended.

Harnesses

If ankle cuffs are used, there should be two attachments of the bungee to the jumper; one to the custom-made ankle cuffs and one to the front waist attachment point of a body harness (either a full-body harness or a sit harness with a chest attachment).

A sit harness alone is not suitable for use, either for the main or back-up attachment.

If ankle cuffs are not used and the jumper is attached to a single attachment point on a body harness either at the front or rear, the attachment point should be connected to by both the main and back up sling from the bungee rope

These slings should be bound together to avoid the risk of entangling limbs, or entrapping necks but in a way that does not impede or prevent regular inspection. Connectors to the harness attachment point should be opposing so their gates are not making contact with each other. Where the rear (dorsal) attachment point is used, suitable and sufficient semi-rigid padding should be fitted around the slings and connectors (and bungee-head if appropriate) to prevent head or neck injury to the jumper. Padding should be removable so as not to impede or prevent regular inspection.

Where possible, always oppose connections where they are side by side and there is a risk of them coming together

Connection of the main and back up slings to a single attachment point on a harness requires additional safeguards to ensure that any significant wear, or damage to the harness, particularly at the attachment point and its associated webbing, is immediately identified and the harness taken out of use. Harness attachment points should be of a type suitable for repeated shock loading. Conventional harness fall arrest anchor points will not be suitable for repeated arrests of bungee jumps for example the edge profile of the metal 'D' ring of the harness anchor point may increase the risk of wear and damage to the webbing at the harness attachment point.



Figure 1 Fall-arrest (single use) attachment - not suitable for multiple loading as harsh angles cause excessive wear to harness webbing



Figure 2 Work-positioning attachment - softer edges reduce wear on harness webbing when subjected to frequent multiple loading

In addition to the thorough examinations set out in 3.1.2, a robust pre-use and in-service inspection scheme is required to ensure that wear or damage to harnesses at and around the attachment points is quickly identified and the harness taken out of use. This will require daily pre-use inspections and periodic inspections of the harnesses during the jump event. This can be done at the same time as the periodic in-service inspection of the bungee ropes.

Full body harnesses should be compliant with BS EN 361:2002. Sit harnesses with chest harness attachment should be compliant with BS EN 813:2008. Alternatively, a custom built chest harness attachment, may be used with a sit harness conforming to EN 813 provided that the chest harness retains its configuration, strength and padding and retains its full capacity for adjustment for the individual jumper and for it to be connected into the sit harness.

Bungee operators should be able to demonstrate that any custom built harness and attachments have been properly designed, manufactured and tested for the purpose of bungee jumping and that they are suitable for the type of bungee jump undertaken.

A suitable range of harnesses, rated to cover all permitted jumper sizes and weights, should be available on site.

All harness attachment points should be:

- rated to at least 20kN
- attached to the bungee rope with a suitable karabiner or similar attachment

Knots should not be used in any webbing of harnesses or harness attachments due to the detrimental effect they have on the strength of the webbing.

Karabiners

Steel karabiners are recommended which should:

- be compliant with BS EN 362:2004 or BS EN 12275:2013;
- have a minimum breaking load of 20kN; and,
- be self-closing and of screw-gate or triple action design.

Where karabiners are duplicated for backup purposes they should be placed with their gates in opposing directions to prevent accidental simultaneous opening.

Other types of connectors

Maillon Rapide screwed closure connectors are also used for some connections in bungee equipment, particularly where connections need to be tamper proof. If used, these should conform to the appropriate British/European standards, 'BS EN 362:PPE against falls from heights:connectors' and 'BE EN 12275:Mountaineering equipment-Connectors-Safety requirements and test methods'

3.1.2 Inspection and record keeping

The Lifting Operations and Lifting Equipment Regulations 1998 (LOLER) will apply to the crane, its connections to the jump off cage, the cage itself, anchor points, harnesses and attachments used by workers.

Anchor points, bungee rope, harnesses, ankle cuffs and associated means of connection provided for use by members of the public are not covered by LOLER. However, an equivalent standard is expected to ensure compliance with Section 3 of the Health and Safety at Work etc. Act 1974.

A LOLER thorough examination regime includes:

- A written scheme for thorough examination of all lifting equipment and accessories drawn up by a competent person
- Six-monthly thorough examination by a competent person.
- Thorough examination of equipment by a competent person following repair or modification

Where the equipment receives heavy use, is exposed to adverse weather or jumps into water etc., then more frequent thorough examination may be required. The person carrying out the thorough examination must have appropriate practical and theoretical knowledge and experience of examining bungee equipment.

Bungee ropes, harnesses, lanyards and other lifting equipment should receive a daily, pre-use visual inspection, and where necessary periodic inspections during the jump event. In the case of bungees, ropes and lanyards this should involve inspection and handling along the entire length of the equipment.

Items of equipment, including harnesses, ropes and karabiners, must be marked or tagged such that they can be uniquely identified. Records should be kept detailing such information as is necessary to manage an item over its expected lifespan. Records may include the:

- type of equipment and unique identification number
- date of manufacture
- date of first use
- age
- number of jumps or times used
- exposure to sunlight and water
- repair history
- safe working load
- date of disposal, etc.

A competent operator will be aware that the life of a rope is limited, both in time and in number of jumps.

Any defective equipment must be clearly marked and removed from service and destroyed or repaired (if it is safe to do so).

Further advice on inspection of fall arrest equipment made from webbing or rope is available in INDG367 at <http://www.hse.gov.uk/pubns/indg367.pdf>

2 *Jump Platform*

The jump platform whether mobile (attached to a crane) or static (at a fixed site) should be suitably designed, with sufficient anchor points for all persons accessing the area.

There should be 2 anchor points each tested to a minimum of 20 kN for attachment of the bungee, and an anchor meeting the requirements in EN 795:2012, requiring a static test of 12kN, for each non-jumper on the platform.

Standards for person-riding baskets for use with cranes (BS EN 14502-1:2010) can be applied to mobile bungee jumping platforms. Any modifications required to allow the jumper to exit the basket, e.g. installation of a gate, should be fit for purpose and not compromise the structural integrity of the basket.

The safe working load (SWL) of the platform must be clearly displayed. The self-weight of a mobile platform will also need to be known since it forms a large part of the load to be lifted.

Employees on the jump platform must use appropriate harnesses and fall restraint lanyards to prevent inadvertently falling or being pulled from the platform. These must be inspected at suitable intervals and maintained in good repair.

Spectators in the jump platform must use harnesses and fall restraint lanyards. Due to the safety critical nature of this equipment, it must be maintained and inspected to an equivalent standard as the employee's harnesses and lanyards.

3.3 *Mobile Cranes*

Where a mobile crane and platform are used then the crane, the attachments

between the crane and the platform, and the platform itself are subject to the requirements of LOLER. The bungee operator must appoint a competent person to plan and manage the lifting operation. The duties of this person, referred to as the Appointed Person, are described in BS 7121-1:2006.

Copies of the current LOLER six-monthly thorough examination reports for the mobile crane, platform, and attachments between the crane and the cage must be available for inspection.

Annex 2 provides detail on the use of mobile cranes.

3.4 Duplication of safety critical equipment

Duplication, that is connection to two separate points of attachment, is required throughout the jump line and is required:

- Between the bungee rope and the jump platform
- Between the bungee rope and the jumper
- Between the mobile platform and the crane hook.

See Section 3.1.1 above for connections to harness attachment points when ankle cuffs are not used.

The connections should be made in such a way that the second becomes active only if the first fails. This is important to prevent, for example, ropes being split by forces acting in two directions

4 Management Arrangements

4.1 Overall management, supervision and competence of staff

Bungee jumping is an activity that exposes those involved to the risk of death or serious injury. The measures required to ensure the safety of employees, jumpers and spectators must be determined by a suitable and sufficient risk assessment.

The risk assessment must consider the particular characteristics of site, platform and equipment. A new jump/site specific risk assessment must be carried out when significant changes, which are likely to have an impact on safety, are made to the jump arrangements, equipment or location. Similarly, a new risk assessment must be carried out where innovative bungee practices are planned.

The potential for human error in safety critical tasks must be considered in the risk assessment, and appropriate measures taken to reduce these risks.

Detailed guidance on Human Factors is available at

<http://www.hse.gov.uk/humanfactors/index.htm>

Competence and supervision of staff are critical. Overall management arrangements must address the selection, training, instruction, competence, authorisation, on-going supervision and monitoring of staff at venues.

4.2 Selection and preparation of site and liaison with host/landlord

Sites should be selected carefully. Where a mobile crane is used, attention should be given to the nature or condition of the ground and its capability to support the crane. Checks should be made for shallow underground services, voids, or overhead obstructions such as power lines. Bungee jump operations require sufficient area on the ground and sufficient unobstructed space in the air. Fencing and/or demarcation will be necessary to prevent spectators and others on the ground inadvertently moving themselves or other objects into the drop zone. Liaison with the host is necessary to ensure all site safety requirements can be accommodated and spectators controlled.

4.3 Control of the site

Appropriate control of the site should be maintained during operations. This should include control of access to, and possible interference with, the crane (if used) and exclusion of spectators from the drop zone. Consideration should be given to any relevant local factors before jumping is authorised. For example, wind speed or wind direction limits established for that set-up on that

site should not be exceeded. Weather conditions must be assessed before any employees work at height.

4.4 *Demonstrating integrity of jump arrangements*

Operators must take steps to demonstrate the integrity of their jump arrangements. Dead weight drop tests are an effective and practical way to demonstrate the crane jib is set to the correct height. They also help to demonstrate jumpers will not strike bridge supports, roofs, trees, ground etc. They are especially useful when testing new ropes, jumping at unfamiliar locations, using a new crane driver, etc.

Relying on instructing jumpers to 'dive' off the platform is not an adequate control measure. The set-up should provide adequate clearance for jumpers who leap and/or perform acrobatics rather than dive.

Different ropes may be used for different jumpers during the day. Therefore dead weight drop tests at the beginning of the day do not guarantee jump line integrity for the whole day. This is one reason why it is imperative all connections are checked, then double-checked, before each and every jump.

Operators may use other methods to ensure the integrity of the set-up. In such cases operators should be able to demonstrate their alternative methods are as equally effective as dead weight drop tests.

5 Procedures

Bungee operators are likely to need written procedures covering the following safety critical activities:

- Selecting, positioning and using equipment at the venue
- Selection and briefing of jumpers and spectators
- Selection of appropriate equipment for each jumper
- Checking of safety critical actions

- Retrieval of jumper
- Emergency arrangements (which should not be reliant on the emergency services)

The above list is not exhaustive.

Procedures should be written to minimise the potential for human error. Responsibility for ensuring procedures are followed should be clearly allocated. Suitable arrangements should be in place to monitor compliance with procedures. Guidance on writing procedures is available at <http://www.hse.gov.uk/humanfactors/topics/procedures.htm>

5.1 Selection and briefing of jumpers and spectators

All jumpers must receive a full briefing of what to expect and the associated risk in the lead up to the jump, the jump itself and the retrieval. Their understanding should be checked and verified. They should have the opportunity to discuss the activity and time to consider before making their final decision to jump. This is particularly important and necessary for those with a pre-existing medical condition that may be exacerbated by jumping. This should be made clear to potential jumpers during the briefing.

People who are intoxicated should not be permitted to jump. The operator's procedures should identify any jumper age or weight (upper and lower) restrictions.

Spectators entering the jump platform should receive a briefing explaining what they must do and the safety reasons for these rules. Those on the ground must be protected from falling objects, for example, cameras or telephones. If the spectators' behaviour is distracting or disruptive this will increase the likelihood of human error. Any briefing should address this issue and aim to prevent such distraction or disruption.

5.2 Selection of appropriate equipment for each jumper

The harness and rope chosen for each jumper must be appropriate for that person's size and weight, as well as the drop height. Typically an operator will have several ropes, each with a different weight rating. The user weight rating should be clearly marked on the rope. In addition to the weight rating colour-coding of ropes according to weight rating may also be adopted to minimise human error.

Operators should be aware that, with crane jumps in particular, the height can vary slightly which will in turn affect the working 'weight range' on a particular 'colour' of bungee rope. It is recommended that the working weight range of each colour of bungee rope is specified on a Rope Selection Table, which is specific to the Jump Height measured on the day with that specific crane.

The weighing of the jumper is an important part of the pre-jump procedure as it informs the choice of rope and harness. The scales used should be kept in good order and periodically checked with known masses. It is good practice for a jumper to be weighed twice on separate scales, by two different members of staff and their weight and bungee rope selection (colour) to be written on their hand and on their consent form.

A competent operator should have detailed procedures on user weight/rope type; user weight/rope extension and rope discard criteria and be able to demonstrate this knowledge.

5.3 *Checking of safety critical actions*

All connections in the jump line must be double checked - that is separately checked by two competent staff. This includes checking the correct rope has been selected, the harness fits correctly, and the attachments have been made correctly. There should be a check to ensure the rope is positioned to minimise obstruction or damage to it during the jump.

5.4 *Retrieval of jumper*

Careful thought should be given to how the jumper will be retrieved. Different

methods of retrieval can be used e.g. lowering the jumper to the ground (or boat if over water), or lifting them back to the jump platform. Whichever procedure is adopted it should be properly planned and carried out by competent persons using appropriate equipment.

5.5 *Emergency arrangements*

Operators must make arrangements for foreseeable emergencies such as crane malfunction, (retrieval) motor failure, injury, collapse of the crane driver etc. Arrangements must be in place to retrieve workers, jumpers and spectators from the platform in the event of equipment malfunction or other foreseeable occurrence. These should be detailed in a written emergency plan. The plan should not be reliant on the emergency services for the retrieval of people suspended at height. Staff must be trained to enact the plan.

As well as workers, bungee operators are recommended to include members of the public (jumpers and spectators) in their first aid needs.

6 Enforcement

Enforcement decisions should be in line with the HSE's Enforcement Policy Statement (EPS) and Enforcement Management Model (EMM).

Annex 1 – Bungee ropes

UK bungee jump operators use either braided or un-braided bungee rope.

Un-braided ropes (Figure 1) consist of multiple rubber strands. They are unsheathed but are bound together by more rubber strands. Un-braided ropes can be unbound to allow inspection of the individual strands. This should only be done by someone qualified to manufacture un-braided bungee ropes, under controlled conditions

Braided ropes (Figure 2) consist of individual rubber strands covered by a permanent sheath. This produces a single cord. Two or more of these cords are bound together at regular intervals along their length to produce a single bungee rope.

The two types of rope perform differently. The sheath on braided rope restricts the extension of each cord. It also restricts the compression of the elastic strands when 'relaxed'. The internal strands are stretched to twice their relaxed length (i.e. pre-stretched). This is why the overall extension during a jump is not nearly as much as an un-braided bungee rope. This results in a shorter drop and a firmer jolt when the rope reaches full extension and begins to shorten. Un-braided rope exhibits much greater extension and is expected to give a longer and smoother bounce. Typically, braided rope can extend by 80-90% of the original rope length, whereas un-braided rope can extend by 300-400%.

Operators should understand the characteristics of the rope they have selected. To illustrate, a 15m braided rope is likely to result in the jumper dropping around 30m, whereas the same length of un-braided rope could result in the jumper falling over 60m.



Figure 3 Un-braided bungee rope



Figure 4 Braided bungee rope

Annex 2 - Mobile Cranes

In bungee jumping, cranes are used to lift and lower employees, spectators and the jumper. Under the Machinery Directive, cranes are supplied under the assumption that they are not for lifting persons. The Approved Code of Practice (ACoP) for the Lifting Operations and Lifting Equipment Regulations 1998 (LOLER) indicate that cranes should only be used to lift persons in exceptional circumstances, when it is not practicable to use less hazardous means.

Bungee jumping is a thrill seeking leisure activity conducted by informed participants. HSE's position is that, provided the risks are properly assessed and effective measures are taken to ensure the safety of all those involved including spectators, it would be inappropriate to rigidly apply this restriction on the use of cranes for this activity.

Operators must ensure that all reasonably practicable measures are taken to ensure the safety of their employees and the public during crane manoeuvring and lifting operations.

Guidance on the lifting of persons with cranes can be found in the BS7121 series of standards. Section 23 of BS7121-1 provides a comprehensive list of additional requirements required for cranes lifting persons.

Where it is not reasonably practicable to achieve compliance with the above standards, then other equally effective means to ensure the safety of employees and members of the public must be implemented.

Use of the crane for the lifting and lowering operation will be subject to the requirements of LOLER. These include that every lifting operation is properly planned by a competent person, appropriately supervised and carried out in a safe manner. The operator must appoint a competent person to plan and manage the lifting operation. The duties of this person, referred to as the Appointed Person, are described in BS 7121-1.

The Appointed Person should visit the site of the planned event. They should identify any hazards that may be in the immediate area and then prepare a Lift Plan, including a drawing showing where the crane is to be positioned.

The selection of the appropriate size and type of crane is a matter for the Appointed Person. The crane used should comply with the requirements for cranes used for lifting persons as described in BS 7121-1 and BS 7121-3. These include specific requirements relating to controls, limiters, switches, brakes and indicators. Cranes manufactured after 1992, and which are CE marked, are likely to comply with these requirements. Particular attention should be paid to older cranes that do not display a CE mark.

The crane should always be configured and jib radius selected so that its Rated Capacity provides a factor of safety that takes account of the static weight of the cage (cage, passengers, operator, lifting accessories and equipment), and any dynamic loads such as wind and those produced during bungee jumping. A significantly increased safety factor is essential as most mobile cranes are not fitted with any secondary safety devices for example, a second rope or independently acting over speed safety gear.

In addition to the requirement for initial and in-service thorough examination and test, LOLER requires daily pre-use checks to be carried out by an appropriately trained and instructed person. The crane should be maintained in accordance with the manufacturer's instructions. A record of the pre-use checks and maintenance should be retained.

The crane must always be operated by a trained and competent operator. There should be a reliable means of communication between the persons being lifted and the person controlling the crane. Effective arrangements should be made to ensure that persons being lifted and suspended can be rescued in the event of an emergency.

Spectators and other members of the public should be excluded from the area underneath the platform or cage. Where persons may need to be below the load, e.g. during retrieval of a jumper, then a safe system of work is required

to minimise the risk to those persons. This is particularly important as the crane driver is likely to be lowering an inverted person (the jumper hanging from a bungee) plus the cage (which may obscure their view) as well as there being persons on the ground below the load. The operation should only be conducted with careful planning, thorough procedures and clear communication. Operators should also take reasonably practicable measures to prevent items falling from the platform or cage.

Crane drivers should be able to take sufficient breaks to rest and refresh themselves. Distractions such as flashing lights or loud music should be kept to a minimum.

Where the crane is not to be manned on a continuous basis the platform should be lowered to the ground during breaks. The platform should not be left suspended without a driver present at the controls at any time.

References

Legal requirements and standards:

- Health and Safety at Work etc. Act 1974
- Management of Health and Safety at Work Regulations 1999
- Lifting Operations and Lifting Equipment Regulations 1998
- Provision and Use of Work Equipment Regulations 1998
- Personal Protective Equipment at Work Regulations 1992
- Work at Height Regulations 2005 (as amended)
- INDG 367–Inspecting fall arrest equipment made from webbing or rope
- LAC 90/4 - Lifting Operations and Lifting Equipment Regulations 1998
- BS 3F 70 1991: Specification for heavy duty braided rubber cord
- BS EN 795:2012 Personal fall protection equipment. Anchor devices.
- BS EN 813:2008 Personal protective equipment for prevention from falls from a height. Sit harnesses.
- BS EN 12275:1998 Mountaineering equipment. Connectors. Safety requirements and test methods.
- BS EN 361:2002 Personal protective equipment for prevention from falls from a height. Full body harnesses.
- BS EN 362:2004 Personal protective equipment against falls from height. Connectors.
- BS 7121-1:2006 Code of practice for safe use of cranes. General.
- BS 7121-3:2006 Code of practice for safe use of cranes. Mobile Cranes.
- BS EN 14502-1:2010 Cranes – equipment for lifting persons – part 1: suspended baskets.
- ***BS EN 362:PPE against falls from heights:connectors***
- ***BE EN 12275:Mountaineering equipment-Connectors-Safety requirements and test methods***
- Australian New Zealand Standard, (AS/NZS 5848:2000 Code of practice for bungy jumping).