

Lifting Operations with 180° and 360° Excavators



Lifting Operations with Excavators

Strategic Forum for Construction Good Practice Guide



Working in Partnership

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Foreword

Construction clients, designers and contractors should do all they can to eliminate, or reduce, the need for lifting operations. Where lifting operations are necessary, the most suitable equipment designed for the purpose should be selected and the work properly planned and managed.

In most instances the most suitable equipment will not be excavators as they are primarily designed for earthmoving. While technical advances over the years have enabled excavators to be used for lifting operations, excavator design introduces additional risks not present in other purpose-designed lifting equipment (such as cranes).

Improper use of excavators in lifting operations has led to a number of serious, and sometimes fatal, accidents. Where excavators are being used for lifting operations, or their use is planned, HSE inspectors challenge users to justify their use.

When a robust risk assessment demonstrates that use of purpose-designed lifting equipment is not reasonably practicable and an excavator could provide a practicable alternative, then only proceed with that once it is established that the design and construction of the excavator is suitable for the lifting operation.

This includes checking that the environment is suitable for that lift to take place, that the additional mechanical devices (such as check valves) that allow a safe lift are provided on the excavator, and the appropriate requirements set out in the CPA guidance are followed. Only at that point is it possible to put in place suitable systems and procedures to plan, supervise and carry out such lifting operations in a safe manner.

The Health and Safety Executive provided support to CPA in producing this guidance. This guidance may go further than the minimum you need to do to comply with the law with regard to workplace health and safety.

Peter Baker

HM Chief Inspector of Construction.

1.0 Introduction and Summary

All lifting operations in the UK must comply with the requirements of the Lifting Operations and Lifting Equipment Regulations 1998, commonly known as LOLER. The Approved Code of Practice and Guidance to LOLER refers to the BS 7121 saying:

“The BS 7121 series of standards contains recommendations for the safe use of cranes, including planning of lifting operations. In this series of standards, the competent person for planning lifting operations is referred to as the appointed person. The principles contained in this series of standards can be applied to the use of other types of lifting equipment.”

Part of the planning process for lifting operations involves selection of suitable lifting equipment for the particular task to eliminate or reduce lifting related risks to people in the workplace. The Provision and Use of Work Equipment Regulations 1998 (PUWER) require employers to ensure that work equipment is ‘*suitable for the purpose for which it is used or provided*’ and that they take account of any additional risks posed by the use of the equipment. **In terms of selection of lifting equipment this means that the first choice should always be machines which have been specifically designed for lifting operations, such as cranes, telehandlers and lorry loaders. An excavator should not be the automatic choice for lifting just because it is already on site and it is quicker and cheaper than using another, more appropriate, piece of lifting equipment.**

Only where a robust risk assessment clearly demonstrates that it is not reasonably practicable to provide machines specifically designed for lifting operations should excavators be considered, and only then if the risks associated with such use can be adequately controlled or other suitable measures put in place to mitigate those risks.

Excavators are primarily designed for excavating and handling loose material, rather than lifting suspended loads. Use of them for lifting operations introduces several additional risks that are not present with purpose designed lifting equipment, such as cranes. These include:

- Fast articulation and slew movements of the boom, dipper arm and bucket (if fitted) which may put persons in the vicinity of the machine at risk and may also affect the stability of the machine. Conventional cranes are designed with slower motions for the precision placement of loads, rather than the fast motions of an excavator to maximise earthmoving production;

***NOTE:** Some excavators have a selectable lift mode which limits some or all motion speeds during lifting operations.*

- The need to operate boom and dipper arms simultaneously to keep the load over the same point on the horizontal plane, whilst lifting or lowering;
- Standard excavator rated capacity alarms only warn of approach to overload, rather than preventing overload as is the case with conventional cranes of all types over 1 tonne capacity;
- Provision for the operator to switch off the alarm to prevent nuisance alarms during earthmoving operations;
- Standard excavator overload warning devices are generally rated with the excavator in its least stable condition i.e. cross carriage. This means that when lifting in line with the tracks/wheels, the alarm will activate well before the maximum rated radius for the load is reached. This frequently leads to operator frustration and switching off the indicator;
- Excavators have the ability to travel with a load on uneven ground even though most load radius charts only cover static lifting;

NOTE: Excavators should not be used for pick and carry duties if they do not have a pick and carry load chart.

- Not all excavator operators have been trained and assessed in carrying out lifting operations with excavators;
- Not all appointed persons have experience of planning and supervising lifting operations with excavators.

Provided you can demonstrate that it is reasonably practicable to safely use an excavator for lifting operations, then this document sets out precautions and procedures that should be taken into account when planning and carrying out lifting operations with tracked excavators, wheeled excavators and backhoe loaders. These precautions and procedures will enable the work to be done safely and in accordance with your legal duties.

This guidance does not specifically address lifting with other types of earthmoving equipment, such as wheeled loaders, however the principles of planning, supervision and execution, set out in LOLER and the BS 7121 series, apply to all lifting operations.

In the UK, the Health and Safety Executive considers that the use of an excavator to move processed material using attachments such as a grab or a magnet is a lifting operation as defined by the Lifting Operations and Lifting Equipment Regulations 1998 (LOLER). Paragraph 28(n) of the HSE Approved Code of Practice and guidance to LOLER – L113 states that an example of lifting equipment is “an excavator (or other earth-moving machinery) adapted to be used for lifting using lifting attachments (e.g. forks, grabs, lifting magnets), but not when used for normal earth-moving operations;” Such lifting operations must be planned, supervised and carried out in accordance with Regulation 8 of LOLER.

NOTE: Northern Ireland has its own set of regulations which tend to mirror those in Great Britain but may have minor differences. Employers should ensure that they are aware of the regulations in the jurisdiction in which they are working.

An example of what can go wrong!

A civil engineering company attempted to lift a muck skip out of a large shaft in 2005. The muck skip was twice the excavator’s safe lifting capacity. As a result the excavator toppled into a 10 metre depth hole, landing on the muck skip and a mini excavator in the shaft.

Fortunately, none of the three people involved were killed and only the excavator operator was injured.

Nobody had received training and no lift plan was in place. The recovery of the excavators and skip involved a contract lift using a 500 and 400 tonnes Liebherr cranes.

2.0 Definitions

attachment

bucket or other device which can be easily attached to the dipper arm of an excavator, either directly or via a quick hitch

180° backhoe loader

a self-propelled machine able to carry front mounted equipment (typically a loading bucket) and a rear mounted backhoe

duties

configurations in which the excavator can be used and the rated capacity for that configuration

employing organization

person or organization who requires a lifting operation to be carried out and is responsible for safe use of the excavator

excavator

a self-propelled machine, with an upper structure capable of turning through 360° that is intended primarily for excavating with a bucket

lifting operation complexity

measure of the complexity of a lifting operation taking into account both the complexity of the load and the environment in which it is being lifted (see **3.4**)

lifting attachment

hook which can be easily attached to the bucket, dipper arm or quick hitch of the excavator, to facilitate the lifting of loads

lift plan

document to describe the planning, organization and execution of a lifting operation

NOTE: This may be stand alone or form part of a method statement for tasks involving the use of an excavator.

load chart

durable load chart which should be affixed in a prominent position, easily readable by the operator including information on rated and actual capacities (see **Figure 1**)

NOTE: This is sometimes referred to as a Rated Object Handling Capacity Table.

object handling

application of earth-moving machinery comprising lifting, lowering and transporting of a load by use of lifting accessories, whereby the assistance of a person or the operator of the machine is required for hooking, unhooking or stabilising (whilst transporting) the load

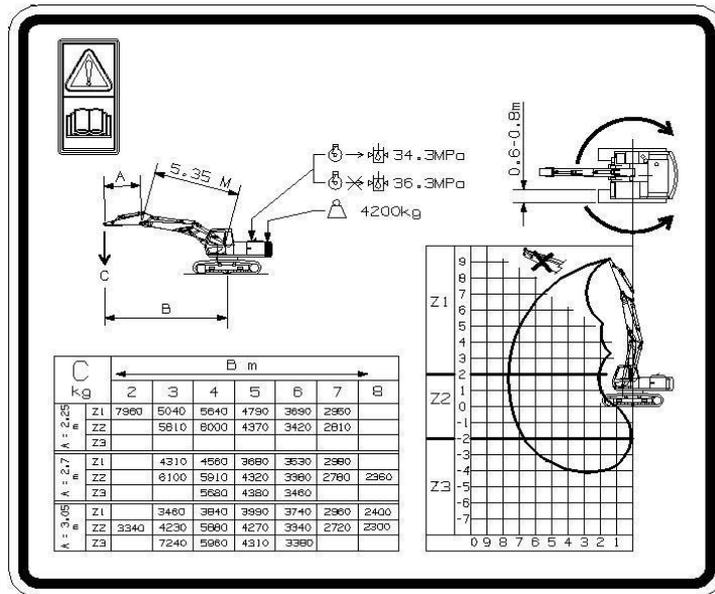
overload warning device

an acoustic or visual warning device which indicates to the operator when the rated lift capacity or corresponding load moment is reached and continues as long as the load or load moment is exceeded

NOTE: An overload warning device does not have the functionality of a rated capacity indicator.

method statement

document produced to describe the safe system of work for the use of a excavator



NOTE: B = Distance of centre of slew to load attachment point

NOTE: Load "C " must include the weight of quick hitch, bucket or other lifting accessory

Figure 1 - Example Load Chart

personnel

appointed person

person nominated (typically by the employing organization) to plan, and to have overall control of, the lifting operations

competent person - general

person who has such capacity combined with practical skills, theoretical knowledge and experience of the excavator and the equipment used in the lifting operation as is necessary to carry out the function to which the term relates in each particular context

excavator operator

person who is operating the excavator

lift supervisor

person who controls the lifting operation, and ensures that it is carried out in accordance with the appointed person's safe system of work including the lift plan

plant marshaller

an appointed individual who guides and assists the movement of plant within a defined route or area and includes the guiding and assisting the operational movement of plant for configuring purposes whilst statically situated. Duties include communicating, providing instructions and guiding plant whilst ensuring safe movement of pedestrians and other vehicles

NOTE: The role is not a direct support role and does **not** include the attaching of loads, providing direct instructions for working (non-marshalling) activities, or connecting/disconnecting components and equipment during a machine's working activities.

signaller

person responsible for directing the excavator operator to ensure safe movement of the excavator and load

site management

person or organization responsible for operations on a construction site or part of a construction site

NOTE: This includes Principal Contractors, package and sub-contractors.

slinger/signaller (from BS 7121:2016)

person responsible for:

- a) attaching and detaching the load to and from the excavator;
- b) correct identification and use of lifting accessories in accordance with the specifications of the appointed person;
- c) initiating and controlling the movement of the load; and
- d) directing the excavator operator to ensure safe movement of the excavator and load.

supervisor

person responsible to higher management for the day-to-day performance of individuals or a small group, guiding the group toward its goals, ensuring that all members of the team are safe, productive and resolving problems, within their competence, as they arise

pick and carry

where an excavator is used to lift a load, travel with the load and place the load

quick hitch

device to facilitate the efficient connection and removal of attachments to excavators

NOTE: Also known as Quick hitches, Quick Couplers or Attachment Brackets (Quick fastening).

rated capacity of excavator

load that the excavator is designed to lift for a given operating condition (e.g. configuration, position of the load)

NOTE: The rated capacity was formerly known as "safe working load" (SWL).

rated capacity indicator

device which gives, within specified tolerance limits, at least a continuous indication that the rated capacity is exceeded, and another continuous indication of the approach to the rated capacity

rated capacity limiter

device that automatically prevents the excavator from handling loads in excess of its rated capacity, taking into account the dynamic effects during normal operational use

stabilizer

aid to the supporting structure connected to the base of the excavator to provide stability, without lifting the chassis from the ground

NOTE: On a 180° machine the front bucket is often used to provide stability.

temporary works coordinator (TWC)

competent person with responsibility for the co-ordination of all activities related to the temporary works

thorough examination

examination by a competent person in such depth and detail as the competent person considers necessary to enable them to determine whether the equipment being examined is safe to continue in use until the next thorough examination

NOTE: The thorough examination is not part of the maintenance regime for the equipment but provides owners with information which could be used to determine the effectiveness of the maintenance regime.

tipping line

the horizontal line about which an excavator will rotate, should it overturn

working load limit (WLL)

maximum load which a sling is designed to sustain in straight lift and which a sling or sling assembly is authorized to sustain in general lifting service

NOTE: Working load limit is generally applied to lift accessories, whilst rated capacity is applied to lifting equipment.

3.0 Planning and Supervision of Lifting Operations

All lifting operations on site should be planned to ensure that they can be carried out safely and that all foreseeable risks have been taken into account. The planning process should identify the most suitable type of lifting equipment for the task, focusing on reducing the risk from the lifting operation to the lowest level reasonably practicable. Poor planning is one of the major causes of the inappropriate use of excavators for lifting operations.

LOLER requires that the siting, setting up and use of lifting equipment is carefully planned so that these activities can be carried out safely and efficiently. The responsibility for planning lifting operations lies with the employer who is undertaking the task. The employer should ensure that they identify one person with sufficient training, practical and theoretical knowledge and experience, who should be appointed to be responsible for planning and supervising the tasks. This person is known as the “*appointed person*”.

The duties of this person are detailed in **5.2.1**.

The appointed person should ensure that the planning for each task includes the following:

- Identifying the task to be undertaken;
- Identifying the hazards associated with the task;
- Carrying out a risk assessment;
- Assigning a category to the lifting operation;
- Selecting the most suitable lifting equipment;
- Identifying control measures, including appropriate monitoring of the lifting operation;
- Determining and developing the method to be used;
- Recording the planning (including any contingency activities for rescue);
- Ensuring that all involved in the lifting operation have the required competence;
- Communicating the plan to all persons involved;
- Reviewing the plan before the tasks starts and incorporating any changing circumstances;
- Monitoring the lifting operation appropriately.

NOTE: For basic lifting operations the planning of each individual lifting operation will usually be a matter for the people using the lifting equipment, such as the operator or slinger/signaller, working within limits set by the appointed person. The person carrying out this part of the planning exercise should have appropriate knowledge and experience. The employing organization should have a simple plan, generic risk assessment and procedures in place, to support them and guide the user towards the selection of the most suitable lifting equipment. The appointed person must ensure that these are in place before the lifting operation starts.

3.1 **Identifying the task to be undertaken**

As the first stage in the planning process, the task to be undertaken should be clearly identified, together with the location and sequence. Part of this process is ensuring that the most suitable equipment is chosen for the task.

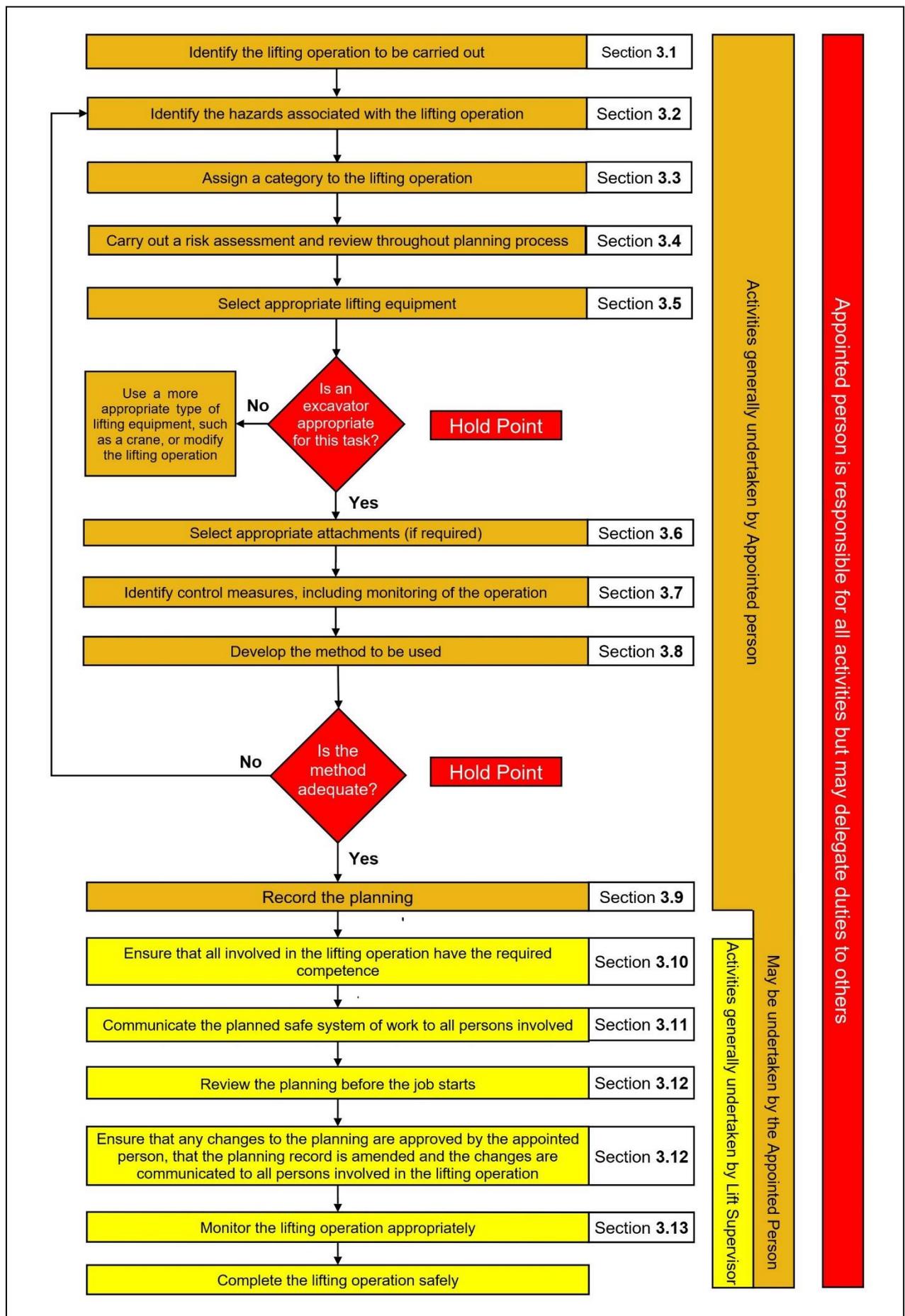


Figure 2 - Flow Chart of Planning Process

3.2 Identifying the hazards associated with the task

The hazards associated with the task should be identified. These might be associated with the location and environment where the lifting operation is to be carried out, the type of lifting equipment to be used, any attachment, the type of load, the location of the pick up and put down points, the travel route, pick and carry duties or the people associated with the task or located in the vicinity. This process should also consider the effect of other operations being carried out in the vicinity and the need for co-ordination (see **Annex A**).

3.3 Lift categories

To enable lifts to be planned, supervised and carried out effectively, three categories of lift are detailed below. The category into which a particular lift will fall depends on the assessment of the hazards associated with both the environment in which the lift is to be carried out and those associated with the load and lifting equipment. A non-exhaustive list of load, lifting equipment and environmental hazards is given in **Annex A**.

As part of the planning process for the lifting operation, the environmental and load/lifting equipment complexities (*the “Complexity Index”*) should be evaluated and categorised as either 1 (low), 2 (medium) or 3 (high). This will then enable the complexity of the lift to be established as shown in **Figure 3**.

As can be seen from **Figure 3**, increases in either or both environmental or load complexity will lead to the lift being allocated a higher category. Having identified the hazards associated with a particular lift, a hierarchy of control measures should be applied to eliminate or control those hazards.

Table 1 shows examples of where the same basic lifting task will fall into different lift categories depending on differing environmental or load complexities.

Environmental complexity (E)	3	Complex	Complex	Complex
	2	Intermediate	Intermediate	Complex
	1	Basic	Intermediate	Complex
		1	2	3
		Load/lifting equipment complexity (L)		

Figure 3 – Relationship between Complexity Index and Lift Category

Complexity variables and constants	Lift category		
	Basic	Intermediate	Complex
Increasing environmental complexity	The operator has clear sight of the load path and the load is to be placed on the ground.	The load is to be placed over an obstruction such that the operator might not have clear sight of the landing area from the control position.	The load is to be placed in a trench behind a bund, without line of sight, and with proximity hazards, such as scaffolding or overhead power lines.
Constant low load/lifting equipment complexity	A load of known weight with designated top lifting points and central centre of gravity. The load does not contain fluids, is not fragile and is inherently stable when landed.	A load of known weight with designated top lifting points and central centre of gravity. The load does not contain fluids, is not fragile and is inherently stable when landed.	A load of known weight with designated top lifting points and central centre of gravity. The load does not contain fluids, is not fragile and is inherently stable when landed.
	Complexity Index E1:L1	Complexity Index E2:L1	Complexity Index E3:L1
Increasing load/lifting equipment complexity	A load of known weight with designated top lifting points and central centre of gravity. The load does not contain fluids, is not fragile and is inherently stable when landed.	A load of estimated weight with an estimated centre of gravity and without designated lifting points. The load does not contain fluids, is not fragile and is inherently stable when landed.	A load of estimated weight and centre of gravity and without designated lifting points. The load contains fluids, is fragile and is not stable when landed.
Constant low environmental complexity	The operator has clear sight of the load path and the load is lifted to and from the ground	The operator has clear sight of the load path and the load is lifted to and from the ground	The operator has clear sight of the load path and the load is lifted to and from the ground
	Complexity Index E1:L1	Complexity Index E1:L2	Complexity Index E1:L3

Table 1 - Examples of the categorization of lifts based on environmental and load complexities

3.3.1 Basic lift

For a basic lift the duties of the appointed person should include the following:

- a) Establishing the complexity of the lifting operation, including load/lifting equipment and environmental complexity:
 - Load complexity will include characteristics such as weight, centre of gravity and presence of suitable lifting points. This can be established by a reliable source of information, measuring and weighing the load, or calculation;

NOTE: Where the weight of the load cannot be accurately established the notional weight should be multiplied by an appropriate factor (typically 1.5) to allow for possible inaccuracies.
 - Consideration of environmental hazards at the location of the operation will include the access and egress required for the lifting equipment and the suitability of the ground to take the loads imposed by the lifting equipment during preparation for the lift and during the lift itself, including any travelling;
- b) Selection of the lifting equipment, based on the load characteristics, including weight of the load and any lifting accessories; the maximum height of lift and the maximum radius required. The rated capacity of different lifting equipment should be specified by the manufacturer. In cases where the lifting equipment has been de-rated at time of thorough examination, the rated capacity stated on the current Report of Thorough Examination, issued by the competent person, should be used. Manufacturer's sales leaflets should not be relied on for the rated capacity of specific lifting equipment;
- c) Ensuring that the surface area of the load is taken into account to ensure that its movement in the wind does not present a hazard e.g. lead to an increased load radius or due to the sail effect increase the effective load;

- d) Ensuring that the lifting equipment has been thoroughly examined at least within the previous 12 months and has been inspected and checked before use. It is essential that the Report of Thorough Examination and associated inspection reports which confirm that the equipment is safe to use are available;
NOTE: The Report of Thorough Examination for the excavator should be carried with the machine.
- e) Selecting appropriate lifting accessories, including their method of attachment to the load, configuration and any protection used to prevent damage;
- f) Ensuring that lifting accessories have been thoroughly examined, at least within the previous 6 months, inspected and checked before use. It is essential that the Report of Thorough Examination is available to confirm that the lifting accessories are safe to use;
- g) Ensuring that a system for reporting and rectifying defects is in place;
- h) Designating a suitable person to check the lifting accessories and any lifting points that are provided on the load to ensure they are free from any obvious defect before attaching the load to the lifting equipment;
- i) Ensuring that the outcomes of the planning process are recorded in a risk assessment and lift plan which should be signed by the appointed person;
NOTE: In many instances a basic lift may be covered by a generic risk assessment and a generic lift plan provided that no additional hazards are identified on site.
- j) Selecting and defining the roles of the members of the lifting team. In some instances, it may be possible to combine some of the roles of members of the lifting team (See **5.3**);
- k) Briefing all persons involved in the lifting operation to ensure that the safe system of work described in the lift plan is understood. All persons involved in the lifting operation should be instructed to seek advice from the appointed person if any change is required to the lifting operation, or if any doubts about safety arise;
- l) If one or more handlines/taglines are required to give more control of the load, the lift supervisor should designate persons to handle the lines;
- m) Checking, if numerous loads are to be lifted over a long period that no changes are required in the safe system of work;
- n) Ensuring that there is a lift supervisor (see **5.2.2**) designated to direct personnel and that the operation is carried out in accordance with the lift plan;
NOTE: It may be possible to combine the roles of lift supervisor and slinger/signaller in some circumstances (see 5.3).
- o) Ensuring that adequate control of access to lifting zones is in place (see **7.4.1**).

The appointed person and lift supervisor should be aware of the limits of their knowledge and experience concerning lifting operations, and when conditions exceed these limits, further advice should be sought.

3.3.2 Intermediate lift

For an intermediate lift the duties of the appointed person should include the following, **in addition** to the duties listed in **3.3.1**:

- a) Identifying all significant hazards in the operating area, including any areas required for access or setting up of the lifting equipment;
NOTE: This may involve the appointed person visiting site if they have any concerns about the detail and quality of the information with which they have been provided.
- b) Ensuring that a site/task specific risk assessment and lift plan, detailing control measures for the identified risks, is prepared;

- c) Liaison with any other person or authority, as required to overcome any hazard, by including any necessary corrective action or special measures in the safe system of work;
- d) Determining any requirement for personnel in addition to the operator, such as a slinger/signaller or dedicated lift supervisor;
- e) Consideration of the effect of the lifting operation on surrounding property or persons, including the general public. This should lead to arranging for appropriate action to minimize any adverse effects, and to giving appropriate notice to all persons concerned.

3.3.3 Complex lift

For a complex lift the duties of the appointed person should include the following, **in addition** to the duties listed in **3.3.1** and **3.3.2**:

- a) Identifying all exceptional hazards in the operating area, including any areas required for access or setting up of the lifting equipment. This will require the appointed person to visit the location of the planned lifting operation as part of the planning process;
- b) Liaison with any other person or authority, as required to overcome any hazard, by including any necessary corrective action or special measures in the safe system of work;
- c) Ensuring that the lift plan includes the exact sequence of operations when lifting the load;
- d) Preparing a sufficiently detailed and dimensioned drawing of the site, lifting equipment and the load, identifying the load path, pick up and set down areas, together with the position of any exceptional hazards in the area. The information provided should be sufficient to enable the operator to position the lifting equipment accurately;
- e) being present on the site during a complex lift, unless they select a competent deputy to attend in their place.

NOTE: Excavators are not generally suitable for complex lifts. Other items of lifting equipment are likely to be more suitable (see **1.0** and **3.5**).

3.4 *Carrying out a risk assessment*

Having identified the hazards associated with the task, a risk assessment should be carried out to identify who might be harmed, the likelihood of them being harmed and the severity of any harm. The assessment should be reviewed at several stages during the planning process and recorded. If any circumstances relating to the planned lifting operation change the assessment should be reviewed to take account of these changes.

3.5 *Selection of lifting equipment*

The findings of steps **3.1** to **3.4**, identifying the lifting operation and the associated hazards and risks, allocating a lift category and risk assessing the activity, should all be considered and used to select the most suitable type of lifting equipment.

Before choosing an excavator, consider the guidance at section **4.0**, *Selection of excavators used for lifting*. If an excavator is considered to be the most suitable type of lifting equipment, record this in the risk assessment and review the decision should any of the assumptions (site conditions, load, environment etc.) change.

Where excavators are specified for lifting suspended loads and travelling with those loads (pick and carry), the planning process must take account of the additional hazards associated with these activities. As excavators are not primarily designed for lifting

loads, the first step should be to ensure that an excavator is the most suitable equipment for carrying out the task (see 4.0).

Unlike a mobile crane or tower crane, an excavator cannot lift a load over a point without the operator simultaneously raising the boom and lowering the dipper arm to keep the suspension point stationary on the horizontal plane. These restrictions may prevent precision lifting operations with small clearances being carried out safely. In such circumstances, the use of alternative lifting equipment will be more appropriate.

Regulation 4 of the Provision and Use of Work Equipment Regulations 1998 (PUWER) requires that employers ensure that work equipment provided for their employees is the most suitable for the purpose for which it is being used and reduces or eliminates risks to the user and other people.

3.6 Selection of lifting accessories

Lifting accessories should have adequate capacity for the load being lifted and be appropriate for the environment e.g. chain slings are generally less susceptible to damage than fabric slings. The rating or WLL of a sling is based on the sling hanging vertically and being connected directly to the load. This rating will be reduced as the angle between the legs of a sling increases or where the method of use differs from a straight connecting of the sling to the load e.g. choked, basket or hashed.

Some points to be born in mind when selecting lifting accessories are:

- Positive attachment of slings to the load is better than using non-positive means such as a choke hitch;
- Protection of slings against sharp edges;
- De-rating of lifting accessories appropriate to the configuration being planned;
- Use of lifting frames/beams to stabilise/control the orientation of the load;
- Removal of the need to have persons in close proximity to the load e.g. for stabilisation or guidance purposes;
- The provision of safe systems of work to ensure loads cannot inadvertently fall or swing, etc. in situations where slingers have to intervene to reconfigure accessories (see 6.16).

3.7 Selection of attachments

Special attachments for lifting should be compatible with the machine and coupling means (quick-hitch) to which they are being attached. The appointed person should verify that the combination is designed to take the load in this manner. This may require clarification from the machine and attachment manufacturers.

3.8 Identifying control measures

Once the risk assessment has highlighted the risks involved in the lifting operation, the procedures and measures required to control them should be identified and recorded. These decisions should be reviewed in the light of changing circumstances and any changes recorded.

3.9 Developing the method to be used

Having identified the hazards, evaluated the risks and worked out the control measures required to carry out the lifting operation safely, these components should be developed into a coherent plan. This should include consultation with those who will be undertaking or be affected by the task. Any contingency measures and emergency procedures should be included in the plan.

3.10 Recording the planning in a Lift Plan

Once the plan has been developed it should be recorded in a Lift plan. The length and detail of this document depends on the complexity of the lifting operation to be undertaken and on the risks involved. The Lift plan should include the following information:

- Project;
- Location;
- Date of issue, revision number and approval sign off;
- Lifting equipment and load description;
- Load stability before, during and after the lifting operation, including checks to be undertaken;
- Pick-up and delivery points;
- Sequence of operations;
- Ground and operational area – assessed and passed as suitable for the lifting and travelling (including pick and carry) operations to be undertaken;
- Requirements for Exclusion Zones and any sequencing of other activities to maintain safe areas;
- Arrangements for adequate supervision of operations;
- Arrangements for signalling between the slinger/signaller and operator;
- Names of personnel involved in the lifting operation;
- Suitable and sufficient information, instruction and training for operator, slinger/signaller and supervisor;
- Authorisation of operator and supervisor;
- Communicate safe method of work;
- Contingency planning;
- Arrangements for ensuring that equipment provided is maintained and fit for purpose;
- Arrangements for ensuring that equipment (including lifting attachments) is thoroughly examined and tested at appropriate intervals;
- Lifting accessories and their configuration.

3.11 Lifting team competence

Before starting the lifting operation, the appointed person should ensure that the members of the lifting team are competent to carry out the lift or series of lifts. A competence or training card does not mean that the holder has the necessary competence to carry out their role in the lifting team for lifts of all complexities (see 5.4).

3.12 Communicating the planned safe system of work to all persons involved

One of the most important aspects of successful planning is to ensure that the contents of the planned safe system of work (lift plan) are communicated effectively to, and between, all parties involved, taking account of language differences. Arrangements should be made to ensure that copies of any lift plans are given and explained to the appropriate people (including the Principal Contractor) and that others involved in the job are fully briefed. Similarly, any changes to the plan should be communicated to all

parties. The chain of communication is generally the appointed person briefing the lift supervisor who then briefs the remainder of the lifting team.

Confirmation of the plan being communicated and understood should be obtained and recorded. This may be by obtaining signatures of those being briefed.

It is essential that part of the communication process includes co-ordination with other activities that may impinge on the task to be undertaken.

3.13 *Reviewing the plan before the job starts*

Immediately before a job starts the specified method should be checked to see if any aspect of the job has changed and the effect that these changes could have on the safety of the operation. If any modifications to the plan are required these should be communicated effectively to all those involved. The competent person should amend the lift plan and initial any significant changes.

3.14 *Monitoring the lifting operations*

The appointed person should undertake or arrange for appropriate monitoring of the lifting operation, particularly if the lift is complex or taking place over a long period of time. The frequency of monitoring should reflect the duration, complexity and environment of the lifting operation.

3.15 *Planning for lifting during deliveries*

The appointed person on a construction should ensure that all lifting operations associated with deliveries or collection of materials, equipment and plant are effectively planned, supervised and carried out safely. This should apply even if materials etc. are being offloaded using a vehicle's own lifting equipment.

3.16 *Further guidance*

Further guidance on lift planning is given in:

- L113 *Safe use of lifting equipment*, HSE Books (www.hse.gov.uk/pubns/books/l113.htm)
- BS 7121-1:2016, *Code of practice for safe use of cranes – Part 1: General*
- **Annex I.**

4.0 Selection of Excavators Used for Lifting

4.1 Selection of Excavators

An effective and safe excavator is one which is well matched to the type and size of load to be carried and lifted, together with the environment in which it is to be used. The selection process should at least take into account the following points:

- Is an excavator an appropriate machine for this application?
- Is the site of adequate size for the use of excavators?
- Can the excavator be made level for the lifting operation?
- What are the weight, dimensions and characteristics of both the excavator and the load(s) to be lifted?
- Does the excavator have load chart for pick and carry duties?
- What are the radii and height of lift required?
- Is additional safety equipment required for this operation? e.g. Full RCI, height and slew restriction.
- How far will the loads have to be carried and over what sort of terrain are pick and carry duties required?
- What are the number, frequency and types of lifting operation?
- What space is available for excavator access, deployment, operation and stowage, including the space required for correct deployment of stabilizers (if fitted)?
- Is there a need for attachments such as buckets, block grabs, grapples or lifting hooks?
- What is the effect of the operating environment on the excavator and vice versa?
- Is operator selection a criterion for machine selection?
- Will the operator have adequate visibility?
- Is an excavator **still** an appropriate machine for this application?

The selection of the excavator and any attachments should be part of the planning process (see 3.0).

NOTE: Account should be taken of the load safety devices fitted to excavators supplied for lifting duties. These will vary depending of the date of first supply. See 4.3.

4.2 Selection of Attachments

Attachments for use with excavators carrying out lifting operations should be chosen with care to ensure that the combination of excavator and attachment is both safe and productive. The fitment of an attachment may alter the lifting capacity of the machine and if the correct load chart is not used there is a risk of overturning or damage to the machine's structure. The selection process should at least take into account the following points:

- Which make and model of excavator is the attachment going to be fitted to?
- What task is the attachment required for?
- Which type of attachment is best suited to the application?
- Is the attachment approved for use on that machine?
- Is the attachment compatible with the excavator?

- Is the hanger/adapter plate suitable?
- Are load charts and user instructions available for the use of the attachment on the specific excavator?
- Is the excavator operator both familiar with and competent to operate the attachment?
- Will the operator require additional training and/or familiarisation (see 5.4)?
- Who will be carrying out fitting and removal of the attachment and are they competent to do so?
- Are there particular hazards associated with the location and/or the task to be carried out?
- Will the attachment be sourced from the excavator manufacturer, from an attachment manufacturer or from a third party?
- Will the attachment be sourced from the excavator owner's own stock?
- Will the attachment be used for the lifting of suspended loads?

Attachments should be designed for use with a specific machine, CE marked to the Machinery Directive and supplied with an EC Declaration of Conformity as items of *"interchangeable equipment"*. They should also be supplied with instructions to enable them to be assembled and used safely with the specific excavator. The instructions should specify which excavators the attachment can be safely assembled and used with, either by reference to the technical characteristics of the excavator or, where necessary, by reference to specific models of excavator. Care should be taken when using attachments designed and manufactured by a third party (not the excavator manufacturer) as these may not comply with the above requirements.

It should be noted that where an attachment is not CE marked or supplied with an EC Declaration of Conformity, the person who assembles the excavator/attachment combination is responsible for conformity of the new machine with the requirements of the Machinery Directive 2006/42/EC.

Specific guidance on the classification and CE marking of attachments is given in: *CECE guidance on the classification of attachments to construction equipment for the machinery directive 2006/42/EC*, Committee for European Construction Equipment.

4.3 Design Requirements

The design of earth moving machinery for lifting (object handling) is covered by the European standard BS EN 474 parts 1, 3, 4 and 5 (see **Annex I**). BS EN 474-1 defines object handling as:

"The application of earth-moving machinery comprising lifting, lowering and transporting of a load by use of lifting accessories, whereby the assistance of a person or the operator of the machine is required for hooking, unhooking or stabilising (whilst transporting) the load."

Any earth-moving machine designed for object handling should have a rated object handling capacity table available inside the cab. An example is shown in **Fig. 4**. If a rated object handling capacity table is not available, then the machine should not be used for object handling.

In the UK, the Health and Safety Executive considers that the use of an excavator to move processed material using attachments such as a grab or a magnet is a lifting operation as defined by the Lifting Operations and Lifting Equipment Regulations 1998 (LOLER). Such lifting operations must be planned, supervised and carried out in accordance with Regulation 8 of LOLER.

An earth-moving machine used for lifting operations must be fitted with a load hooking device or a suitable attachment for direct handling of processed material, such as a grab or magnet. This load hooking device may be mounted on the excavator dipper, quick hitch or bucket. If the load hooking device is a hook then this should have a clip or other device which prevents a sling slipping off the hook. Many quick-hitches provide a load hooking device in the design of the hitch. All load hooking devices should be marked with their rated capacity.

If the rated lifting capacity for an excavator or the backhoe portion of a backhoe-loader is greater than 1 tonne (or the overturning moment is greater than 40,000Nm) then the machine must be fitted with:

- a) a boom lowering control device on the raising (main) boom cylinder(s) and which meets the requirements of ISO 8643:1997 *and*
- b) an acoustic or visual warning device which indicates to the operator when the object handling capacity or corresponding load moment is reached (see 4.7).

NOTE: Where a risk assessment shows that there is a significant risk of overloading and/or overturning on machines with a rated capacity of 1 tonne or less, a Rated Capacity Indicator may be required. (See LOLER ACOP and Guidance paragraph 117).

Suitable slings must be available to attach the load to the excavator. Slings and other lifting accessories should be CE marked, and marked with the safe working load.

A change in the definition of *rated object handling capacity* in the latest version of EN474 has affected new excavators manufactured and CE marked after 29th December 2009. It requires any new excavator which has a rated capacity of over 1 tonne, and which is going to be used for lifting, to be fitted with an RCI and hose burst check valves. Previously some manufacturers had been marking the excavator for a rated lifting capacity of 1 tonne even though it had a rated capacity of well in excess of this.

NOTE: Excavators manufactured, and CE marked before 29th December 2009 are not affected by these changes.

A further change to the requirements of EN 474-5 occurred in July 2012 which requires that all new machines supplied after that date must be fitted with hose burst check valves on the dipper arm cylinder as well as the main boom cylinders.

Summary

- An excavator can be supplied without being equipped for lifting duties, but in such a case there should be nothing in the supply to encourage the belief that the machine is suitable for lifting. Such a machine should not be used for lifting suspended loads under any circumstances.
- An excavator which is equipped for lifting should be equipped with hose burst protection valves and an overload warning system if the rated capacity is over 1000kg at any point in the working range.

4.4 Load Charts

All excavators used for lifting should be fitted with a rated object handling capacity table, which is more commonly known as a load chart. The chart shows the rated capacity of the excavator in a given configuration for a range of radii from the centre of slew, heights and distance below ground. The example in **Figure 4** shows the information both in tabular form and as a curve on a grid.

NOTE: Load charts are based on the machine standing stationary on firm level ground and are not valid in other situations.

Load charts for excavators with crawler or wheeled undercarriages generally give two rated capacities for a given radius - one over the front or rear and one over either side. Care should be taken to establish whether the rated capacity includes the weight of the

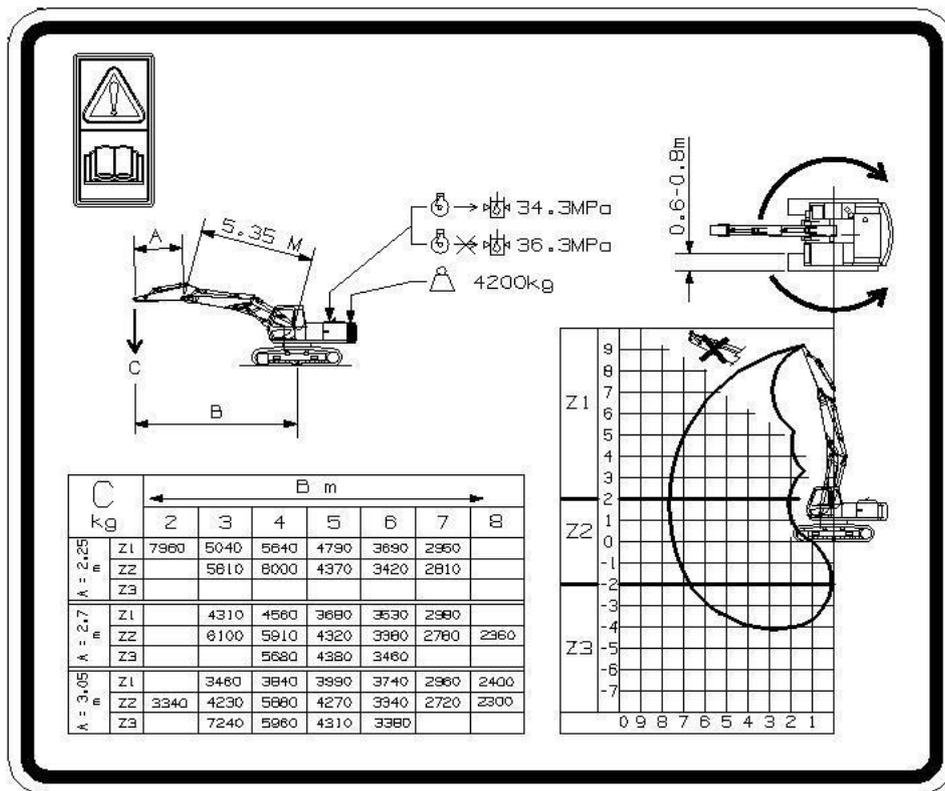
bucket or any other attachment, or whether the weight of the bucket or other attachment has to be deducted from the rated capacity shown on the chart.

Care should also be taken when using attachments such as quick hitches and tilt rotators which will move the suspension point of the lifting accessories from that specified on the load chart. This may well increase the load radius and consequently reduce the rated capacity of the excavator.

Specific models of excavator can be configured in a number of ways with different booms and dippers, different track configurations, two piece booms and different counterweights. All of these will affect the machine's rated capacity and it is essential that the correct load chart is used for lift planning and that a check is made to ensure that the excavator cab is fitted with the correct load chart before any lifting operation starts.

Additionally, wheeled excavators will also have different rated capacities depending on whether they are fitted with outriggers and/or a blade and if the outriggers or blade are deployed. Some machines are fitted with axle locks which automatically release on travel, drastically altering the stability characteristics when carrying out pick and carry duties.

The example in **Figure 5** shows rated capacities with outriggers up and outriggers down. It also shows capacities in both metric and imperial units and care should be taken when reading dual unit load charts to ensure that they are correctly interpreted.



NOTE: B = Distance of centre of slew to load attachment point

NOTE: Load "C" must include the weight of quick hitch, bucket or other lifting accessory

Figure 4 - Example of a Load Chart for a Crawler Excavator

At the arm end, without bucket and quick fit. Unit: 1 000 kg. **With heavy counterweight.**
 For lifting capacity including bucket/quick fit, simply subtract actual weight of those parts from the following values.

Across under-carriage	Arm end (bucket pivot) related to ground level	Reach from machine centre (u = support up/d = support down)																														
		1.5 m				3 m				4.5 m				6 m				7.5 m				Max.										
		u	d	u	d	u	d	u	d	u	d	u	d	u	d	u	d	u	d	u	d	u	d	u	d	Max.						
5.5 m 2-piece boom 2.9 m dipper arm Outriggers front and rear	9 m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.4*	5.4*	5.4*	5.4*	4.3		
	7.5 m	-	-	-	-	-	-	-	-	5.0*	5.0*	5.0*	5.0*	4.1	5.5*	5.5*	5.5*	-	-	-	-	-	-	-	-	3.8	4.3*	4.3*	4.3*	6.3		
	6 m	-	-	-	-	-	-	-	-	5.3*	5.3*	5.3*	5.3*	4.1	5.3*	5.3*	5.3*	-	-	-	-	-	-	-	-	2.8	4.0*	4.0*	4.0*	7.4		
	4.5 m	-	-	-	-	8.4*	8.4*	8.4*	8.4*	6.1	6.7*	6.7*	6.7*	3.9	5.9*	5.7	5.9*	2.7	5.4	4.0	5.6*	2.4	3.9*	3.5	3.9*	8.1						
	3 m	-	-	-	-	-	-	-	-	5.5	8.9*	8.4	8.9*	3.7	6.9*	5.5	6.9*	2.6	5.3	3.9	6.0*	2.1	3.9*	3.2	3.9*	8.4						
	1.5 m	-	-	-	-	-	-	-	-	5.0	10.9*	7.8	10.9*	3.4	7.2	5.2	7.9*	2.5	5.1	3.8	6.5*	2.0	4.1*	3.1	4.1*	8.5						
	0 m	-	-	-	-	-	-	-	-	4.7	10.9	7.5	12.1*	3.2	6.9	5.0	8.7*	2.4	5.0	3.6	6.9*	2.1	4.3	3.2	4.6*	8.3						
5.5 m 2-piece boom 3.2 m Grab Arm Outriggers front and rear	-1.5 m	-	-	-	-	8.3*	11.0*	11.0*	11.0*	4.6	10.8	7.4	12.2*	3.1	6.8	4.9	8.9*	2.3	4.9	3.6	6.9*	2.2	4.7	3.4	5.3*	7.8						
	-3 m	-	-	-	-	8.5	16.6*	14.8	16.6*	4.6	10.8	7.4	11.4*	3.1	6.9	4.9	8.3*	-	-	-	-	-	-	-	2.6	5.6	4.1	6.8*	6.9			
	9 m	-	-	-	-	-	-	-	-	5.7*	5.7*	5.7*	5.7*	-	-	-	-	-	-	-	-	-	-	-	-	5.5	6.1*	6.1*	6.1*	5.0		
	7.5 m	-	-	-	-	-	-	-	-	-	-	-	-	-	4.4	5.3*	5.3*	5.3*	-	-	-	-	-	-	-	3.5	5.7*	5.0	5.7*	6.8		
	6 m	-	-	-	-	-	-	-	-	-	-	-	-	-	4.3	5.2*	5.2*	5.2*	3.0	5.5*	4.3	5.5*	2.8	5.3	4.0	5.4*	7.8					
	4.5 m	-	-	-	-	-	-	-	-	6.4	6.4*	6.4*	6.4*	4.2	5.9*	5.9*	5.9*	3.0	5.6*	4.3	5.6*	2.4	4.6	3.5	5.2*	8.5						
	3 m	-	-	-	-	-	-	-	-	-	-	-	-	-	3.9	6.9*	5.7	6.9*	2.8	5.5	4.1	6.1*	2.2	4.3	3.2	5.2*	8.8					
5.5 m 2-piece boom 2.45 m dipper arm Blade rear	1.5 m	-	-	-	-	-	-	-	-	-	-	-	-	3.7	7.4	5.4	8.0*	2.7	5.4	4.0	6.6*	2.1	4.2	3.1	5.4*	8.9						
	0 m	-	-	-	-	-	-	-	-	4.9	11.2	7.7	12.1*	3.4	7.2	5.2	8.8*	2.6	5.2	3.9	7.0*	2.1	4.3	3.2	5.8*	8.7						
	-1.5 m	-	-	-	-	-	-	-	-	4.8	11.0	7.6	12.5*	3.3	7.0	5.1	9.1*	2.5	5.2	3.8	7.2*	2.3	4.6	3.4	6.4*	8.2						
	-3 m	-	-	-	-	8.6	15.9*	14.9	15.9*	4.8	11.0	7.6	11.9*	3.3	7.0	5.1	8.8*	-	-	-	-	-	-	-	2.6	5.3	3.9	6.6*	7.4			
	9 m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.2*	7.2*	7.2*	7.2*	3.3		
	7.5 m	-	-	-	-	-	-	-	-	5.8*	5.8*	5.8*	5.8*	-	-	-	-	-	-	-	-	-	-	-	-	4.1	4.6	5.4*	5.4*	5.6		
	6 m	-	-	-	-	-	-	-	-	6.0	6.0*	6.0*	6.0*	3.8	4.2	5.6	5.8*	-	-	-	-	-	-	-	2.9	3.2	4.4	4.8*	6.9			
5.5 m 2-piece boom 2.6 m dipper arm Blade rear	4.5 m	-	-	-	-	10.2*	10.2*	10.2*	10.2*	5.6	6.2	7.4*	7.4*	3.6	4.0	5.5	6.4*	2.5	2.8	3.8	6.0*	2.4	2.7	3.7	4.7*	7.6						
	3 m	-	-	-	-	-	-	-	-	5.0	5.7	8.0	9.6*	3.4	3.8	5.2	7.3*	2.4	2.7	3.7	6.3*	2.1	2.4	3.3	4.8*	8.0						
	1.5 m	-	-	-	-	-	-	-	-	4.6	5.2	7.4	11.4*	3.1	3.5	5.0	8.2*	2.3	2.6	3.6	6.7*	2.0	2.3	3.2	5.1*	8.1						
	0 m	-	-	-	-	-	-	-	-	4.3	4.9	7.2	12.2*	3.0	3.4	4.8	8.8*	2.2	2.5	3.5	6.8	2.1	2.3	3.3	5.6*	7.9						
	-1.5 m	-	-	-	-	7.8*	9.1	11.8*	11.8*	4.3	4.9	7.1	12.1*	2.9	3.3	4.7	8.8*	-	-	-	-	-	-	-	2.3	2.5	3.6	6.7*	7.3			
	-3 m	-	-	-	-	-	-	-	-	4.4	5.0	7.2	10.9*	3.0	3.4	4.8	7.9*	-	-	-	-	-	-	-	2.8	3.1	4.4	7.1*	6.4			
	9 m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.5*	6.5*	6.5*	6.5*	3.7		
5.5 m 2-piece boom 2.6 m dipper arm Blade rear	7.5 m	-	-	-	-	-	-	-	-	5.5*	5.5*	5.5*	5.5*	-	-	-	-	-	-	-	-	-	-	-	3.9	4.3	5.0*	5.0*	5.9			
	6 m	-	-	-	-	-	-	-	-	5.8*	5.8*	5.8*	5.8*	3.8	4.2	5.7	5.7*	-	-	-	-	-	-	-	2.8	3.1	4.3	4.5*	7.1			
	4.5 m	-	-	-	-	9.6*	9.6*	9.6*	9.6*	5.7	6.3	7.2*	7.2*	3.6	4.0	5.5	6.2*	2.5	2.8	3.8	5.9*	2.3	2.6	3.6	4.4*	7.8						
	3 m	-	-	-	-	-	-	-	-	5.1	5.7	8.0	9.3*	3.4	3.8	5.2	7.2*	2.4	2.7	3.7	6.2*	2.1	2.3	3.3	4.4*	8.1						
	1.5 m	-	-	-	-	-	-	-	-	4.6	5.2	7.5	11.3*	3.1	3.5	5.0	8.1*	2.3	2.6	3.6	6.7*	2.0	2.2	3.1	4.7*	8.2						
	0 m	-	-	-	-	-	-	-	-	4.3	4.9	7.2	12.2*	3.0	3.4	4.8	8.8*	2.2	2.5	3.5	6.8	2.0	2.3	3.2	5.2*	8.0						
	-1.5 m	-	-	-	-	7.8*	9.1	11.5*	11.5*	4.3	4.9	7.1	12.1*	2.9	3.3	4.7	8.9*	-	-	-	-	-	-	-	2.2	2.5	3.5	6.2*	7.5			
-3 m	-	-	-	-	-	-	-	-	4.3	4.9	7.2	11.1*	3.0	3.3	4.8	8.1*	-	-	-	-	-	-	-	2.6	3.0	4.2	7.0*	6.6				

Figure 5 - Example of a Load Chart for a Wheeled Excavator

For pick and carry operations the ground conditions such as evenness, flatness, longitudinal and cross slopes should be taken into account. Slopes are of particular concern as the lift chart is only valid with the machine stationary on firm level ground.

4.5 Stability

The stability of excavators when lifting depends on the position of the combined centre of gravity (C of G) the excavator and the load it is lifting. As can be seen in **Figure 6**, if the combined C of G is inside the tipping line the turning effect or moment of the C of G about the tipping line will keep the tracks on the ground and the machine will be stable. If, however the excavator is overloaded and the combined C of G moves outside the tipping line, as in **Figure 7**, the moment of the C of G about the tipping line will cause the machine to tip.

Figure 8 shows the increase in load radius caused by the excavator on a slope. The effect of this increase in load radius will be to reduce the machine's stability. This increase in load radius may not be indicated by the excavator's instruments.

The position of the tipping line determines the stability of an excavator when lifting and will change depending on the slew position of the boom and whether the undercarriage is tracked or wheeled. Wheeled under carriages will have different stability characteristics depending on the use of locking oscillating axles, outriggers and blades.

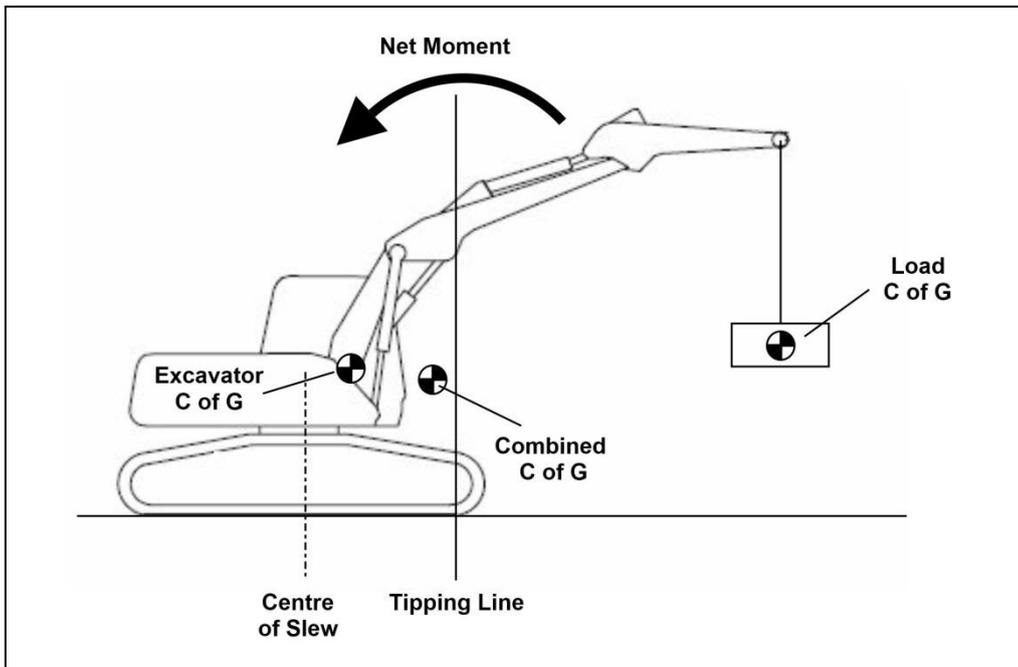


Figure 6 - Stable Excavator with Combined Centre of Gravity Inside the Tipping Line

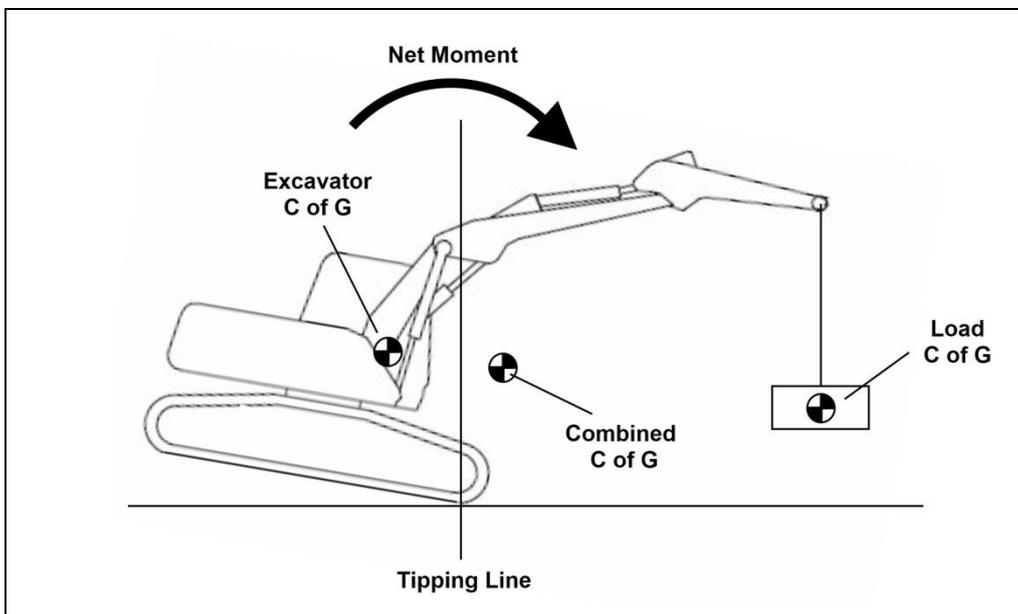


Figure 7 - Unstable Excavator with Combine Centre of Gravity Outside the Tipping Line

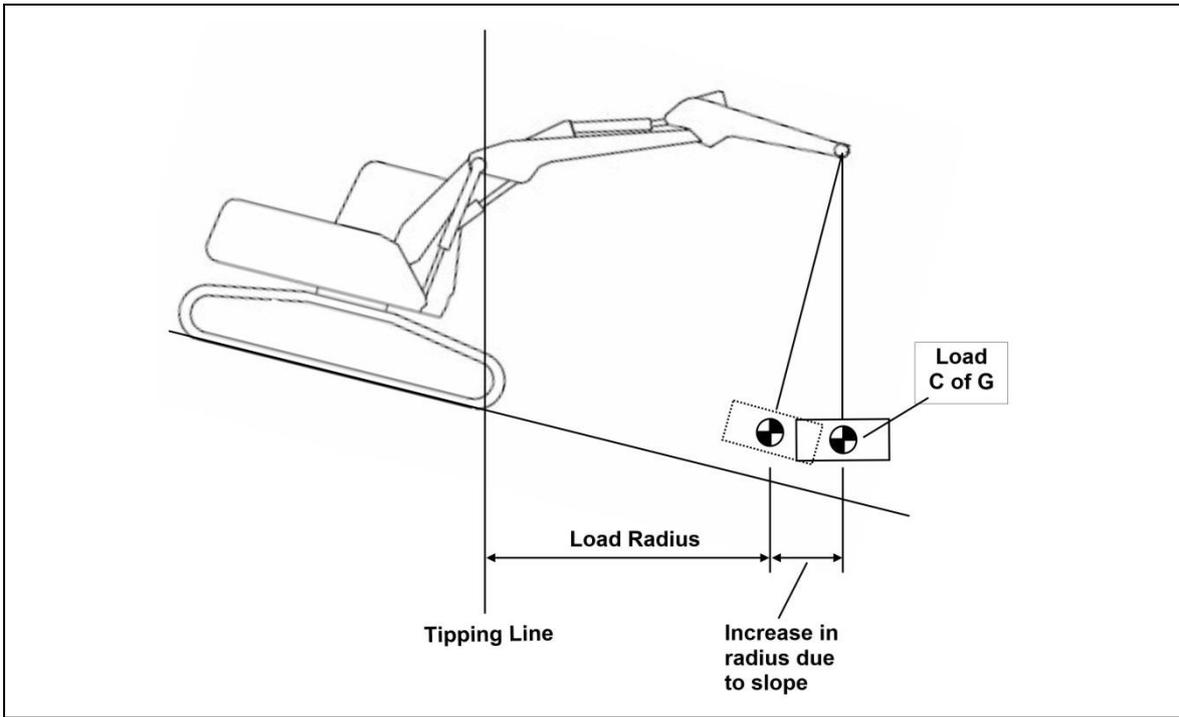


Figure 8 – Adverse Effect of Slope on Load Radius

Figure 9 shows that for a tracked type undercarriage, as the side tipping line is closer to the centre of the machine than the front and rear tipping lines the machine will be less stable when lifting over the side than when lifting over the front or rear.

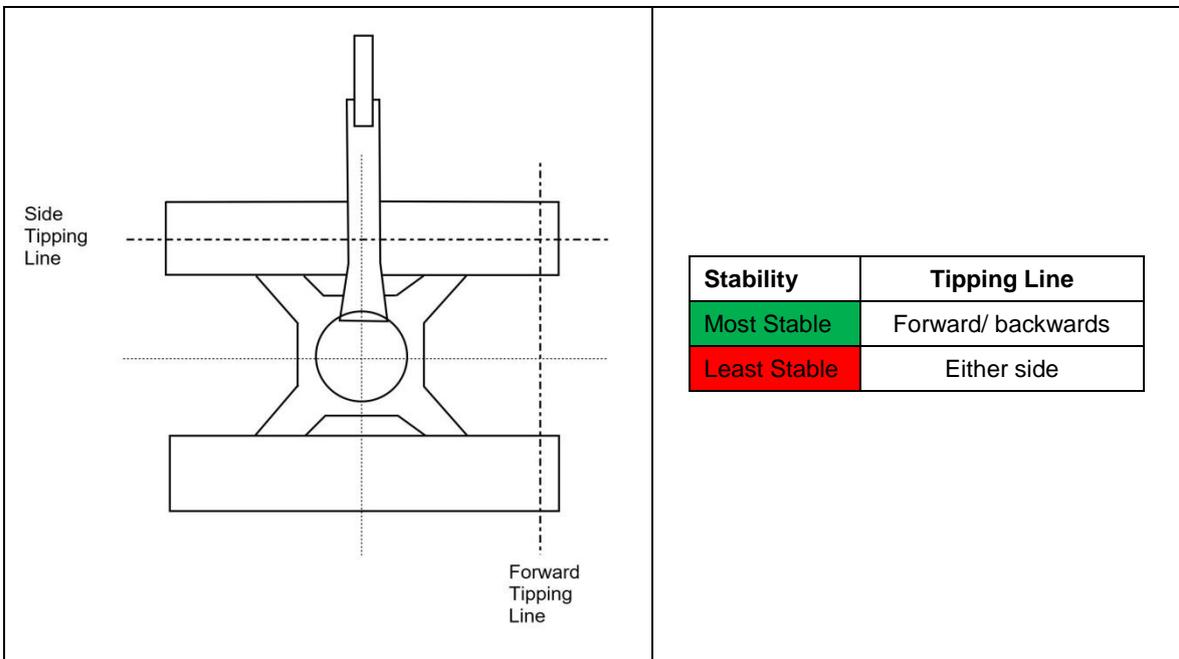


Figure 9 - Tipping Conditions for a Tracked Type Undercarriage

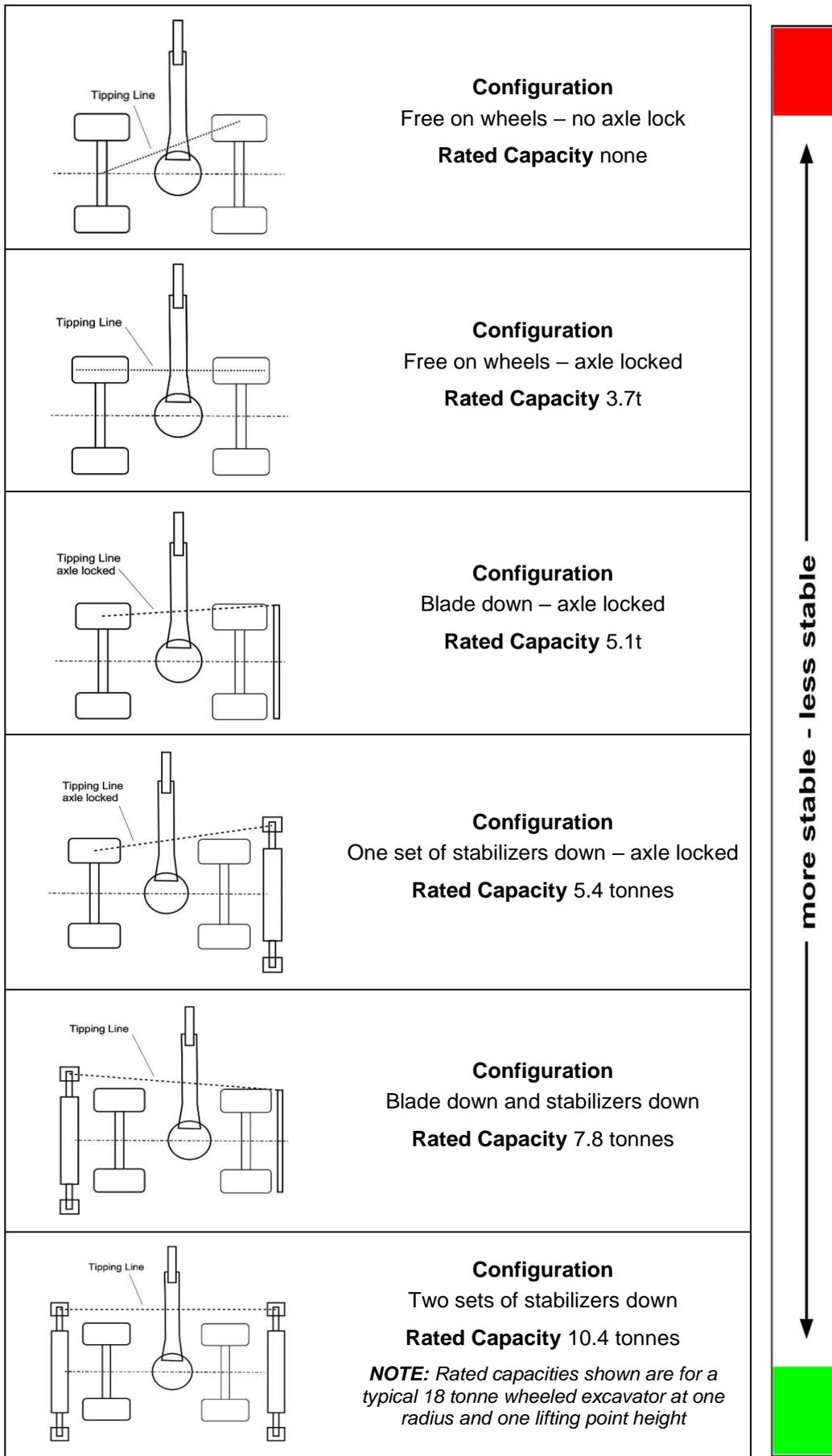


Figure 10 - Tipping Conditions for a Wheeled Undercarriage with Stabilizers or a Blade

Figure 10 shows that for a wheeled undercarriage, the side tipping lines vary significantly depending on the locking or not of an oscillating axle and the deployment of outriggers or a blade. As shown, the deployment of axles locks, blades and stabilizers has a significant effect on the rated capacity of the excavators.

The position of the front tipping line also depends on the deployment of outriggers or a blade. As a general rule a wheeled excavator will be more stable and have better lifting capacities with the oscillating axle locked or the outriggers/blade deployed.

NOTE: Rated capacities shown in **Figure 10** are for a typical 18 tonne wheeled excavator at one radius and one lifting point height.

4.6 The Effect of Tyres on Stability

Tyres play a vital part in the stability of 360° wheeled excavators and 180° backhoe loaders. Stability and load carrying capacity can be adversely affected by issues such as:

- Incorrect tyre pressure;
- Differences in diameter of tyres on the same axle due to differential wear;
- Differences in diameter of tyres on the same hub for twin wheel machines;
- Incorrect ply rating;
- Use of tyres which are not of the required performance specification;
- Tyres with identical nominal sizes being of different physical size;
- Poor tyre repairs.

Tyre maintenance, repair and replacement are dealt with in more detail in **Annex H**.

4.7 Overload Warning Devices and Rated Capacity Indicators

Where excavators used for lifting have a maximum rated capacity greater than or equal to 1,000 kg, or an overturning moment greater than or equal to 40,000 Nm they must be fitted with an acoustic or visual warning device which indicates to the operator when the rated lift capacity or corresponding load moment is reached and continues as long as the load or load moment is exceeded.

The excavator operator should always ensure that the overload warning device is activated prior to any lifting operation.

The standard overload warning device fitted by excavator manufacturers is not a rated capacity indicator or limiter as fitted on most cranes. Overload warning devices are generally calibrated with the excavator in its least stable condition i.e. cross carriage. This means that when lifting in line with the tracks, the alarm will activate well before the maximum rated radius for the load is reached. This frequently leads to operator frustration (see the example in **Table 2**).

<i>Lifting Configuration</i>	Rated Capacity in tonnes at 3m Lift Point Height			
	<i>Max. Radius</i>	<i>9m Radius</i>	<i>7.5m Radius</i>	<i>6m Radius</i>
Over End	4.9	6.5	7.7	9.0
Over Side	3.6	4.1	5.5	7.8
% of rated capacity at which overload warning alarm will sound when lifting over end	73%	63%	71%	87%

Table 2 – Example of Early Sounding of Overload Warning Alarm for a 30 tonne Excavator

The HSE's guidance to LOLER states that "*Where there is a significant risk of overturning and/or overloading arising during the use of any lifting equipment, devices such as rated capacity indicators and rated capacity limiters, which provide audible and/or visual warning when the safe lifting limits are being approached, should be provided.*"

Excavators can alternatively be fitted with full rated capacity indicators, either at time of first supply or at a later date. These alternative rated capacity indicators are more sophisticated and will deal with the issue of differing capacities at differing slew angles. They can also provide the limiting of functions when an overload occurs, data logging, display the mass of the load being lifted and allow pre-setting of height, minimum radius, maximum radius, depth and slew.

The advantages of using rated capacity indicators/limiters are that the operator will get an accurate display of corresponding load moments, regardless of how the machine is configured, allowing them to configure the machine correctly for lifting, without having to physically measure height radius or slew angles, the display also gives them information pertaining to, the mass of the load being lifted and allows programming for pre-setting of height, minimum radius, maximum radius, depth and slew restrictions.

Limiters also provide hydraulic lockout/limiting functions when a percentage of overload occurs, also the information is data logged giving the employer peace of mind and allows them to better plan and control lifts.

The function and calibration of both overload warning devices and rated capacity indicators should be checked at the intervals specified by the manufacturer, after any major repair and at each thorough examination.

NOTE: The requirements for overload warning devices on excavators equipped for lifting are set out in EN 474-5. The requirements in BS 7262 do not apply to excavators.

4.8 Visibility

4.8.1 360° Excavators

Restricted visibility when the boom is raised and when large loads are carried coupled with poor segregation have been identified as a major cause of accidents involving pedestrians and 360° excavators. The great majority of 360° excavators feature a left-hand side-mounted cab and a centrally-mounted boom meaning that the operator's view around the machine when normally seated is partially or fully obstructed or 'masked'. The cab frame, and the boom and dipper in certain angles and configurations during work further restricts all-round vision and prevents a clear view, particularly when slewing to the right. Other parts of the machine such as the rear engine covers or counterweight also restricts rear and three-quarter side views.

4.8.2 180° Excavators

When using the backhoe unit for work activities, the operator's view of the bucket and surrounding area can depend upon the position of the backhoe relative to the centre line of the machine. The operator station is located along the machine's centre-line and working with an offset backhoe (where it is positioned to one side of the machine) can reduce visibility with certain configurations of the boom and dipper during work. Slewing the boom/dipper away from the operator is when the risk is highest due to the lack of full visibility.

4.8.3 Preventing collisions

The most effective way of preventing accidents between pedestrians and excavators is segregation. Operators should always ensure by appropriate means, prior to commencing a task, that personnel are clear of the area immediately around the machine. This may involve getting out of the cab and walking around the machine. This role may also be undertaken by the slinger/signaller.

On 360° excavators, to mitigate collisions with structures, objects or persons, the front of cab must face direction of travel and no reversing should take place. Where this is not possible due to areas of minimal room, exclusions zones and/or a marshaller should be employed.

On 180° excavators, one of the highest risks to pedestrians, structures or objects is when the excavator is being reversed, particularly when boom and dipper are folded across the rear of the machine, for which visibility is severely restricted. This is further compounded in that the operator is seated in a forward direction and is reliant on using the reversing mirrors, or turning the upper part of their body to ensure that the machine's path is clear. Exclusions zones and assistance from a marshaller should be employed in areas of pedestrian movement. The working area that covers the working range of the boom and dipper should be cordoned off to prevent unauthorised access, and places of safety clear of the working range of the machine should be facilitated for supporting staff working with the machine.

Operator visibility is aided by clean cab windows and mirrors, and window and mirror cleanliness should form part of the operator's pre-use checks.

Guidance on the assessment of visibility and the selection of visibility aids is given in:

- HSE Sector Information Minute No. 02/2007/02 *Assessing Field of Vision for Operators of Earth Moving Machinery on Construction Sites*
- HSE Safety Notice FOD 1-2015 - *Earth Moving Machinery – changes to visibility requirements*
- **Annex I.**

5.0 Planning, Supervisory and Operating Personnel

5.1 *The Lifting Team*

All lifting operations should be carried out by the lifting team. The team will consist of persons carrying out the following roles:

- a. Appointed person;
- b. Lift supervisor;
- c. Excavator operator;
- d. Slinger/signaller.

The complexity and size of the job will determine the exact team structure but all roles must be allocated and the duties discharged.

NOTE: *In certain circumstances, it might be possible to combine some of the roles of members of the lifting team (see 5.3).*

5.2 *Roles and Responsibilities*

5.2.1 Appointed Person

- a. Planning the lifting operation (including approval of all risk assessments, lift categorizations and lift plans), selection of the lifting equipment and lifting accessories, instruction and supervision, and consultation with other responsible bodies to ensure effective collaboration as is necessary for the work to be undertaken safely (see 3.0);
- b. Ensuring that the outcomes of the planning process are recorded in a lift plan;
- c. Ensuring that adequate pre-operational checks, intermediate inspections, maintenance and thorough examination of the equipment have been carried out (see 8.0 and 9.0);
- d. Ensuring that there is an effective procedure for reporting defects and incidents and for taking any necessary corrective action;
- e. Taking responsibility for the organization and control of the lifting operation;
- f. Ensuring that the lift supervisor and other members of the lifting team are competent to carry out their roles and are fully briefed on the contents, scope and limits of the lift plan (see 3.10 and 3.11);
- g. Being familiar with the relevant parts of the project health and safety plan where the lifting operation is being carried out on a site where the Construction (Design and Management) Regulations 2015 apply;
- h. Liaising effectively with the site temporary works coordinator regarding relevant issues such as ground stability;
- i. Putting contingency and emergency plans in place.

NOTE: *The appointed person should have required understanding and experience of planning lifting operations with excavators.*

NOTE: *The appointed person may delegate duties and tasks, but not responsibilities, for any part of the safe system of work to suitably qualified individuals.*

5.2.2 Lift Supervisor

All lifting operations should be supervised by a lift supervisor. For basic lifts this role may be combined with that of slinger/signaller, whilst for more complex lifts a separate person will be required (see 5.3).

NOTE: *The degree of supervision required will depend on the category of lift and the outcomes of the risk assessment.*

The lift supervisor should direct and supervise the whole lifting operation, ensuring that it is carried out in accordance with the lift plan. The lift supervisor should be competent and suitably trained and should have sufficient experience to carry out all relevant duties.

NOTE: Competence requirements for self-supervision might differ from those for supervising others.

The lift supervisor should also have sufficient authority to stop the lifting operation if they consider it dangerous to proceed.

NOTE: The appointed person may decide to undertake the duties of the lift supervisor or to delegate these to another person with appropriate expertise for the lifting operation.

5.2.3 Excavator Operator

The excavator operator should be responsible for the correct operation of the excavator in accordance with the manufacturer's instructions and within the safe system of work, as detailed in the lift plan.

The excavator operator should respond only to the communications from the slinger/signaller, who should be clearly identified.

The excavator operator should:

- a. Have the necessary competence (skills, knowledge and experience) to carry out lifting operations;
- b. Be familiar with the excavator to be operated, check that it is in good condition and that it has sufficient capacity to carry out the lift safely;
- c. Ensure that they do not wear loose clothing, which could snag on the controls and lead to unintended movement;
- d. Ensure, before the lifting operation starts, that the bucket is removed from the machine if the lifting attachment (hook) is fitted to the quick hitch or dipper end;
- e. Ensure that lifting operations are only carried out with the excavator in lifting mode and the overload warning device or rated capacity indicator/limiter selected;
- f. Ensure that they have been briefed on and understand the lift plan;
- g. Identify the other members of the lifting team and ensure that they are clear of the excavator's arc before operating the machine;
- h. Check that the area where the excavator is to be positioned for the lifting operation is suitable for the task, the landing area is suitable to take the load, the area is segregated from the rest of the site and that only those personnel directly involved in the lift are within the segregated area;
- i. Ensure that the pre-use checks of the lifting accessories to be used have been carried out and that the lifting accessories have been correctly attached to the excavator's lifting attachment;
- j. Ensure that the excavator's control isolator (dead man) is selected when the lifting accessories and load are being attached to avoid unintended movement;
- k. Only follow signals from the designated slinger/signaller during the lifting operation, using the established and agreed pre-arranged system of communication;

NOTE: It is essential that the excavator operator responds immediately to an emergency stop signal from any person.

- l. Ensure that they are happy with the way in which the load has been slung and do not proceed with the lift until they are;
- m. Stop the lifting operation if they are not happy with the way that it is proceeding;
- n. Always conduct a test lift to check that the load is secure, before lifting the load to its landing area;
- o. Ensure that if the overload warning device indicates an overload at any time during the lifting operation, they lower the load in a safe landing area & consult the lift supervisor;
- p. Ensure that when the load has been landed, the slinger/signaller indicates that the load has been disconnected and the lifting accessories are connected back on the master link before moving the excavator;
- q. Ensure that if the load is being travelled from the lifting to landing area, they check that the route is clear, it is safe to carry out the operation and that the slinger-signaller guides the excavator, whilst taking care to keep out of the path of the excavator.

5.2.4 Slinger/signaller

The slinger/signaller should be properly trained in all aspects of slinging loads and signalling, working with excavators, and be authorized by the appointed person.

The slinger/signaller should be responsible for:

- a. Carrying out pre-use and post-use checks of lifting accessories;
- b. Attaching and detaching the load to and from the excavator load-lifting attachment;
- c. Using the correct lifting accessories and other equipment in accordance with the lift plan;
- d. Initiating and directing the safe movement of the excavator using an established and agreed pre-arranged system of communication. If there is more than one slinger/signaller, only one of them should have this responsibility at any one time, depending on their positions relative to the excavator;
- e. Guiding movements of the excavator during pick and carry lifting operations;
- f. Ensuring that they are readily identifiable as the designated slinger/signaller by the excavator operator.

NOTE: Movement of the excavator includes pick and carry duties.

NOTE: Where continuity of signalling is required and this slinger/signaller is not visible to the excavator operator, another slinger/signaller or signaller will be necessary to relay signals to the excavator operator. Alternatively, other audio or visual methods may be used. A typical examples of audio methods used are where a slinger/signaller using a radio continuously instructs the operator to lower a load, e.g. by saying "Lower...lower...lower...", and failure of this continuous instruction from the slinger/signaller indicates that the operator needs to halt all excavator movements.

NOTE: Where a delivery vehicle driver is carrying out slinging and signalling during unloading of materials and equipment the appointed person should ensure that they are competent to do so and have been fully briefed on the lifting operation.

5.2.5 Maintenance personnel

Maintenance personnel should be responsible for maintaining the excavator and ensuring its safe and satisfactory operation. They should carry out all necessary maintenance in accordance with the manufacturer's maintenance manual and within the safe system of work.

NOTE: Further information on the selection, appointment and maintenance personnel is given in BS 7121-2-1:2012.

5.3 Combination of roles

In certain circumstances, it might be possible to combine some of the roles of members of the lifting team. However, as this may introduce additional risks the combination of roles should only take place following a review of the lifting operation by the appointed person.

All lifting operations should be planned by an appointed person.

The combination of roles should only be considered if the person undertaking the combined role has achieved the necessary competence for each role.

NOTE: Competence requirements for self-supervision might differ from those for supervising others.

Activity	Role	Lift Category		
		Basic	Intermediate	Complex
Planning	Appointed person	Required	Required	Required
Site visit	Appointed person	Not essential	May be required	Required
Lifting operation	Appointed person	Not essential, role may be combined with lift supervisor	May be required	Required
	Lift supervisor	Roles may be combined	Roles may be combined	Required
	Slinger/signaller			Required
	Operator		Required	Required

NOTE: This table is for guidance. It is the appointed person's responsibility to determine the combination of roles for each lifting operation.

Table 3 – Combination of Lifting Team Roles

5.4 Training

5.4.1 Assessment of Training Needs

As part of personnel selection, an assessment should be made of the extent of training which is needed for an individual, bearing in mind that this could be influenced by any previous training and experience. When supervisors or operators are recruited, it is essential that employers check that their skills and experience relate to the job they are to do. Where the type of excavator to be used is outside the employee's skill set or previous experience, additional training must be provided. In any event, some further job specific training is likely to be necessary.

5.4.2 Training

Any gaps in the knowledge, skills and understanding required for the tasks must be remedied by suitable and sufficient training. This may be carried out in-house or by an external training provider. At the end of the training period, the trainee must be assessed to ensure that the learning objectives have been met.

Training courses offered by training providers and certification bodies should be checked to ensure that lifting and, where relevant, travelling with suspended loads activities forms part of the training and assessment process. When specifying lifting operations training for their employees, the employer must ensure that the training programmes confirms that operator is assessed as competent at the end of the training period.

Selected training providers and trainers must be able to demonstrate that they have appropriate expertise of lifting operations with excavators. Expertise on lifting operations with, for example on 360° excavators does not automatically infer ability to train on 180°

excavators, and vice versa. Learning programmes, whether employer or training body delivered, should be based on skill standards set by the requisite industry standard-setting body, and any training should include appropriate knowledge of slinging and signalling techniques and methods.

5.4.3 Assessment

Employers should ensure that personnel are assessed against industry-devised occupational standards to establish that they are competent to carry out the tasks they are required to undertake. This applies equally to personnel recently completing training and experienced workers who have been recently recruited.

Assessment should contain both practical activities to demonstrate the skills and standards achieved and the answering of questions to demonstrate relevant underpinning knowledge. The assessment should be carried out by occupationally competent and authorised assessors.

5.4.4 Applying Learnt Skills in the Workplace

On the majority of excavator operator training programmes, for safety reasons, candidates do not operate the machine at its full potential in terms of placing heavy loads at full operating reach. Consequently, employers should ensure that newly trained operators are limited to activities and/or working areas encountered within the training programme until they become confident in operating to the parameters experienced within training. When being required to place heavy loads at full reach and/or height, appropriate supervision must be applied to ensure the operator can safely carry out the task.

Employers and supervisors should be aware of skills attained during the training course and provide further specific training as required. Manufacturers and importers of plant and attachments, as well as external training providers, who offer lifting with excavators training, can be approached for advice on relevant training requirements.

Employers and supervisors should undertake the following for newly qualified operators:

1. Specify any particular work requirements to nominated training providers prior to the commencement of training;
2. Establish the type and the content of training and/or assessment programmes undertaken by the operator;
3. Identify differences in learnt skills and work site activities utilising training body learning outcomes and/or training material;
4. Initially limit the operator to activities and/or working areas measured by the end assessment;
5. Provide time for the operator to study the machine's operating notes/handbook and other related data;
6. Provide time and facilities for the operator to practice with a new machine type;
7. Monitor work undertaken to gauge operator confidence and ability;
8. Introduce new activities and/or working areas under supervision, especially if working within hazardous or busy areas;
9. Carry out periodic assessments and ascertain when new or high risk activities can be undertaken safely;
10. Provide specific additional training for specific types of attachment.

NOTE: Learning outcomes and a training syllabus for lifting with excavators is available from various construction-focussed plant card registration schemes. Training content is based on national occupation standards and can be downloaded at www.citb.co.uk/cpcs

5.5 **Familiarisation**

5.5.1 General

Excavators and attachments come in a variety of types, sizes and differences in operating controls, methods and characteristics. It is therefore essential that operators and supervisors are given adequate familiarisation on an unfamiliar type or model of excavator and/or attachment before they begin operations. **The employer of the excavator operator is responsible for ensuring that familiarisation is provided.**

Familiarisation may be carried out by:

- an experienced person employed by the excavator owner or;
- a representative of the excavator or attachment manufacturer or supplier or;
- any other competent, experienced and authorised person*.

* **NOTE:** *This could be the operator of the machine (see 5.5.2).*

The person giving familiarisation should have been authorised by a suitable person in a supervisory position, after checking that they are competent to do so.

All familiarisation should be recorded by both the operator and their employer.

Familiarisation for the operator of an excavator should include the following for lifting operations:

- Layout and use of all controls and gauges;
- Extracting, applying and following data from information sources such as lift plans, machine specifications, machine decals, operator's manuals, load capacity charts etc.;
- Identification of information and warnings supplied by rated capacity indicators or overload warning systems;
- Identification of specific areas of risk whilst using the specific excavator and/or attachment;
- Machine specific safe working procedures for connection and disconnection of attachments;
- Machine specific visual inspections of the excavator or attachment;
- Machine specific "pre-start checks" and basic maintenance requirements as recommended by the manufacturer;
- The specific machine instruction manual should be provided to the operator while they are at the machine;
- The operator should be given time to read and understand the specific machine operating instructions.

An example check list for carrying out familiarisation is shown in **Annex B**.

5.5.2 Self-Familiarisation

In certain circumstances, the operator may be the best person to familiarise themselves with new equipment, attachments, activities or methods of work etc. where other personnel with the relevant technical or working knowledge and appropriate experience are not available to carry out the familiarisation.

Where the operator undertakes self-familiarisation, they must have:

- Relevant and sufficient experience with the machine, or similar types if the machine to be used is different;

- Relevant and sufficient experience with similar types of work activities and/or attachments;
- Is provided with and able to extract, understand, apply and follow information from sources such as the operator's manual, lift plans, manufacturer's specific technical data etc.;
- Is given sufficient time away from productive work to allow the familiarisation to be carried out and practiced.

Factors such as additional supervision and segregation of supporting personnel and exclusion zones should be implemented until competency of the activity or attachment has been achieved.

5.6 Further guidance

Further guidance on training is given in:

- *Competence to Operate Construction Plant - Good Practice Guide*. Strategic Forum for Construction - Plant Safety Group
- **Annex I.**

6.0 Specific Issues

6.1 *Hooking devices and slinging*

Where the hooking device (the point on the machine designed for connection of the load) is not part of the bucket, the bucket should (where possible, and unless the operator instructions specify otherwise) be removed in order to improve visibility and reduce the weight being lifted. If the bucket is retained, then the weight of both the bucket and quick-hitch has to be added to the load when determining whether the load is within the rated capacity, unless the load chart allows for the weight of the bucket (see 4.4).

When attaching lifting slings to the hooking device or lifting point care should be taken to ensure that the slings and their attachments are able to hang free at all times. Attachment using a shackle may limit rotation if, for example, a pipe suspended from the slings is to be turned end for end (see **Figure 11**). **Figure 12** shows the addition of a swivel to overcome this problem. Similarly, if the quick hitch is tilted backwards and/or the dipper arm is raised, the master link of the sling and any attachments may be put into bending or twisting – possibly leading to damage or failure (see **Figures 14 & 15**). These issues may reduce the height to which a load may be lifted to less than that indicated in the machine's rated object handling capacity table. It is good practice to ensure that the quick hitch is in the vertical position to minimise the load in the dipper cylinder and hydraulic circuit.

Some manufacturer's manuals show a sling passing over the back of the bucket. This practice should not be carried out as there is a danger of the sling becoming displaced during slewing or travelling, the load dropping in an uncontrolled fashion and/or the sling being damaged by the sharp edge of the bucket. This practice may also increase the load radius.

6.2 *Unsuitability of excavators for the lifting of persons*

Excavators should **not** be used for the lifting or lowering of persons as they are primarily designed for excavating with a bucket and consequently have high operating speeds and movements which can make them totally unsuitable for the lifting of persons.

The only exception to this is where an excavator is fitted with a CE marked fully integrated platform which will convert the excavator into a Mobile Elevating Work Platform (MEWP).

Non-integrated platforms should not be used on excavators as the platform tilt cannot normally be locked.

Access to height on construction sites should be by machines designed for the purpose of lifting persons such as MEWPs, mast climbing work platforms, suspended access platforms or passenger/goods hoists, or by the use of scaffolds (see **Annex I**).

NOTE: LOLER requires all lifting equipment used for the lifting of persons to be thoroughly examined at intervals not exceeding in six months.

NOTE: The Work at Height Regulations require that all planning of work at height should include planning for rescue.

6.3 *Use of excavators for multiple lifting*

Excavators should not be used for multiple lifting as they are primarily designed for earthmoving and consequently have high operating speeds and movements. In addition, the need to operate both boom and dipper arms simultaneously to maintain vertical lifting or lowering of the load makes excavators totally unsuitable for multiple lifting, where a great degree of precision of movement at slow speed is required.

The exception is to this is multiple lifting with excavators for specific tasks in controlled circumstances such as rail replacement on railways.



Figure 11. - Master link rotation restricted to approx. $\pm 70^\circ$



Figure 12. – Swivel allows unrestricted rotation but reduces available headroom



Good Practice

Figure 13. – Chain and master link can hang freely without obstruction



Figure 14. – Hitch tilted backwards with master link subject to bending



Figure 15. – Hitch tilted backwards with master link subject to twisting

6.4 **Site conditions**

Employers have legal obligations to plan and control the operation of excavators on site. Operators and contractors need to be made aware of site hazards which could affect the safe use of excavators and of site rules which limit where they may be used.

Particular attention should be paid to:

6.4.1 Control of access to the lifting zone

Sites should be arranged so that wherever possible pedestrians and vehicles are adequately separated by establishing:

- Pedestrian only areas from which vehicles are completely excluded;
- Safe designated pedestrian routes to work locations;
- Vehicle only areas, especially where space is limited or traffic is heavy;
- Safe vehicle routes around the site.

When planning the movement of vehicles on site, including pick and carry routes, the advice given in HSG 144 (see **Annex I**) should be followed.

Access to the lifting zone should be carefully controlled to ensure that personnel not associated with the lifting operation are excluded to reduce the risk of contact with the excavator or load being lifted.

***NOTE:** On some house building sites the site is organised so that excavators deliver material to the front of the houses and pedestrians enter the properties via the rear. Drives are laid early in the planning process to provide good lifting surfaces.*

6.4.2 Site Housekeeping

Areas where an excavator may be used should be kept free of rubbish such as bricks, pallets, timber, etc. Such debris can significantly affect the safe operation of an excavator when lifting suspended loads.

6.4.3 Roads, Access Ways and Entrances

Consolidated roads, free from potholes, should be provided at the earliest possible stage of site development to minimise the need to travel on uneven or unstable terrain. Where off road operation is unavoidable, operators should be made aware of hazards which could contribute to overturning risks or other factors that can affect the safe use of an excavator. These include loss of steering control/direction, loss of traction and braking – even on level surfaces, hidden obstacles, visibility (mud coating mirrors) and loads fouling the ground.

6.4.4 Ground Conditions

The appointed person must be confident the excavator loads can be safely supported by the ground. In case of doubt, the AP should consult the project temporary works co-ordinator (TWC). Similar consideration must be given where excavators are sited on suspended slabs or positioned near retaining walls or adjacent to excavations or embankments, particularly those with a temporary works permit system in place.

The ability of the ground to support the excavator will depend upon the type of excavation, the nature of the ground and ground water conditions. The condition of spoil heaps also requires careful monitoring as they can be adversely affected by rain or wet weather.

Detailed guidance on the assessment of ground conditions is given in the Strategic Forum for Construction's Good Practice Guide on *Ground Conditions for Construction Plant* which can be downloaded from www.cpa.uk.net

6.4.5 Underground Services

The area where the lifting operation is to take place, including any pick and carry route, should be assessed to ensure that any underground services are located and measures put in place to ensure that the services are not damaged and that they do not affect the stability of the excavator.

Detailed guidance on the location of underground services is given in HSG 47 *Avoiding Danger from Underground Services*.

6.4.6 Overhead Power Lines

Where an excavator is in the vicinity of overhead power lines an exclusion zone should be established around the line and any other equipment that may be fitted to the pole or pylon. Envelope restrictors may be used to reduce the working envelope of the excavator (see 4.7). The minimum extent of these zones varies according to the voltage of the line, as follows:

- low-voltage line – 1 m;
- 11 kV and 33 kV lines (pole mounted) – 3 m;
- 132 kV line (tower mounted) – 6 m;
- 275 kV and 400 kV lines (tower mounted) – 7 m.

Figures 16 shows the minimum heights above ground level for overhead power lines and can be used for the identification of line voltage from the type of pole or pylon.

In case of doubt the electricity supply authority should be consulted. Further advice is given in HSE Publication GS6 - *Avoidance of Danger from Overhead Electric Power Lines 2013*, HSE Books.

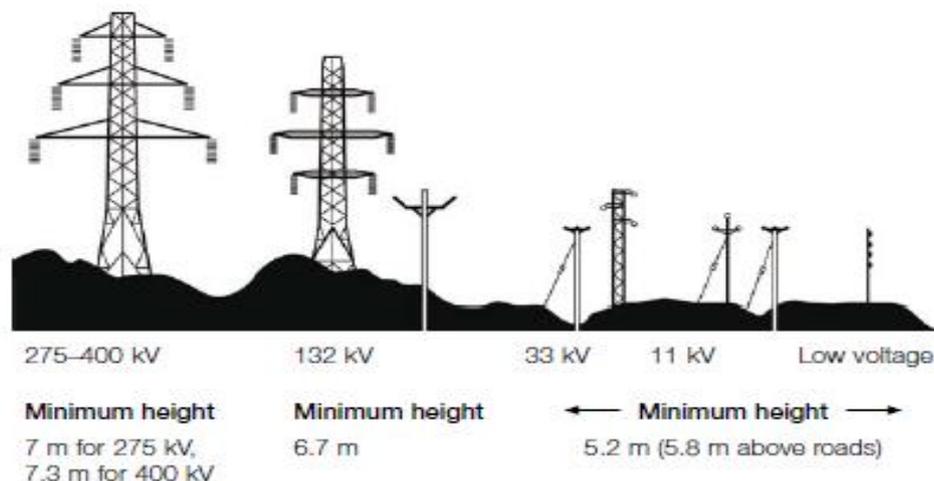


Figure 16 - Minimum heights above ground level for overhead power lines

6.5 ***Weight of the load to be lifted***

The operator of an excavator should always be provided with the accurate weight of the load to be lifted. This can be ascertained from:

- The manufacturer's data plate;
- Markings on the load;
- Manufacturer's data sheets or instructions;

- Drawings;
- Shipping documents;
- Weighing the load.

Where this is not possible the load should be estimated by calculating the volume and using the information given in **Table 4**. Such calculations should be undertaken with caution as the load may not be a regular shape, it may be made from several materials or it may be hollow and contain other materials which may move when lifted.

Material	Weight - kg/m³	Weight - lb/ft³
Aluminium	2 700	170
Brass	8 500	530
Brick	2 100	130
Broken Glass	1 290 –1 940	80 –121
Coal	1 450	90
Concrete	2 400	150
Copper	8 800	550
Earth	1 600	100
Gravel (loose, dry)	1 522	95
Iron and Steel	7 700	480
Lead	11 200	700
Oil	800	50
Paper	1 120	70
Sand (dry)	1 602	100
Sand (wet)	1 922	120
Water	1 000	62
Wood (hard)	500 - 1000	31 - 62
Wood (soft)	350 - 850	22 - 53

NOTE 1 In some cases the values given are an average and the actual weight could vary according to the particular composition/water content, etc.

NOTE 2 All values have been rounded for convenience of use.

NOTE 3 When dealing with a hollow structure or container, check whether or not it contains anything and whether or not any such contents are liable to move.

NOTE 4 When assessing the load, ensure that the weight of the lifting accessories and/or container used for handling the material is included.

Table 4 - Weights of Material

6.6 Lifting with 180° Backhoe Loaders

6.6.1 Variable-positioning Backhoe

The boom and dipper combination of the backhoe is fixed on a kingpost, which itself slews on a carriage (excluding centre-post types). The carriage is located on an H or carriage frame which extends across the rear of the machine and fixed to or forming part of the main chassis. The backhoe can be re-positioned by sliding the carriage to varying positions on both sides of the frame. Stabilizers are located at each end of the frame and should be employed when the backhoe is being used.

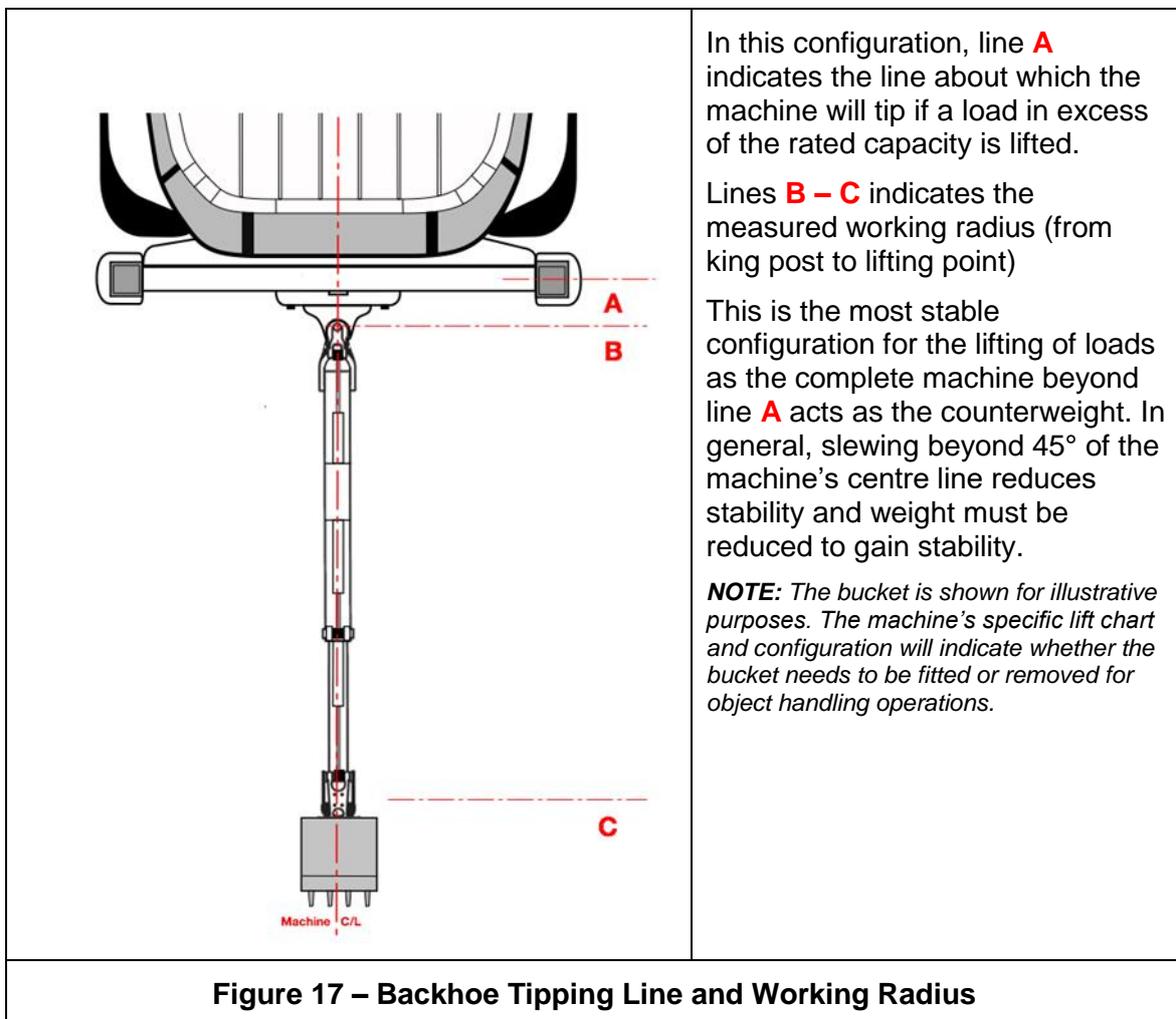
Lifting suspended loads with the backhoe unit of a 180° excavator requires great care as the risk of instability can be high when the machine is in certain configurations. When carrying out lifting and earthmoving operations with the backhoe, the stabilizers become the tipping point of the machine, particularly when working near to or side-on to the

machine. If lifting with the boom slewed beyond the machine's centre line, the distance between the kingpost and the corresponding stabilizer affects sideways stability as any counterweight effect is reduced. When the distance between the carriage and stabilizer is reduced, less counterweight effect means less weight can be lifted and moved.

Effective stability only occurs when working with the carriage in the centre of the frame and the boom kept within a specified arc (usually 45°) from the centre line of the machine. However, slewing the boom beyond (approximately) 45° of the centre line will proportionally increase the tipping moment and decrease stability.

When working within an arc from about 45° to 90° of the centre line, effective stability only occurs when the carriage is at the furthest point away from the stabilizer leg. Working side on with an offset carriage positioned to the working side greatly increases instability.

In principle, for maximum stability, lifting operations should only take place when the carriage is central and the arc of the boom kept within a given area - usually 45°. Operating outside of this arc means lifting capacity is reduced by as much as 75% when working side-on to the machine. Whenever a carriage is repositioned within the frame, in all cases, the carriage must be locked via the hydraulically-operated locking system before lifting duties commence.



6.6.2 Use of stabilizers

Before lifting operations commence, the stabilizers should be lowered so that the machine's weight is taken off each tyre but with the tyres touching the ground, and the machine levelled by adjusting each leg up or down as required. The front loader bucket

provides additional stability and must be lowered to the ground and taking the weight of the front of the machine but with tyres just touching the ground. In some cases, manufacturers will specify that the front bucket is tilted or in the dump position and operators must check what configuration is required for their machine. Failure to lower the bucket decreases stability as axle oscillation allows the chassis to rotate on the axle.

The nearer the boom is to either stabilizer the greater the point loading of that stabilizer. On poor ground this can cause the stabilizer to sink, which increases instability, placing most of the machine's weight onto the corresponding tyre. Stabilizers need to be supported with spreader plates of an appropriate stiffness and bearing area. The front loader may also experience some ground sink and constant checks need to be made to the stabilizers and front loader during lifting operations and adjustments made accordingly.

Advice on ground conditions and point loadings can be found in the Strategic Forum for Construction's Good Practice Guide on *Ground Conditions for Construction Plant* which can be downloaded from www.cpa.uk.net

6.6.3 Machines fitted with ride-control systems

Ride control systems allow a certain level of float within the front loader arms which decreases machine pitch during road or site travel, increasing operator comfort and productivity. This is achieved by the addition of a gas-filled accumulator fitted within the hydraulic circuit of the lift and lower function. The ride control system must be switched off or disabled before the front bucket is lowered for backhoe operations, otherwise the inbuilt float system will allow an upward movement of the front loader, vastly reducing sideways stability.

6.6.4 Extending dippers

Many 180° excavators are fitted with an extending dipper on the backhoe. These can cause two additional issues with stability and lifting capacity:

1. The radius is further increased, decreasing the weight that can be safely lifted;
2. The additional weight of the extending dipper adds to the overall weight to be lifted and further reduces lifting capacity.

When consulting manufacturer's specifications for the planning of lifting duties, the correct specifications for the relevant type of dipper must be referred to.

6.6.5 Planning lifting operations with 180° Excavators

As with 360° excavators, the lifting capacity for a given radius must be known during the planning stage of the lifting operation. Factors to be taken into account by the appointed person include the positioning of the machine, configuration for picking up the load, the position of the backhoe within the 180° working range for picking and placing the load, the amount of slew needed to place the load, and the impact of stability and loads imposed on the stabilizer legs during the slew.

Some manufacturers of 180° excavators will only allow lifting duties to be carried out if one or more of the following conditions are complied with:

- the carriage is central to the machine;
- the bucket is removed;
- the extending dipper is locked in the retract position;
- the dipper ram is fully extended.

Operators and planners must check manufacturer's requirements before lifting operations are carried out.

180° excavators are not designed for pick and carry duties and such duties must not be carried out.

6.6.6 Lifting with the front loader

No lifting of suspended loads should take place unless a manufacturer's approved lifting point is available on the front loader, the machine is supplied for lifting suspended loads and where the maximum rated lifting capacity is specified.

Some front buckets may be equipped with one or more eyes that are drilled within, or welded to, the bucket. These are provided for recovery, handling or maintenance purposes and must not be used for lifting duties unless clearly specified as appropriate for lifting duties and are marked by the manufacturer with the maximum lifting capacity (see 4.3).

Although forks may be fitted to a multi-purpose front bucket, lifting accessories must be not fitted and used to lift suspended loads from the forks.

6.7 *Fork attachments*

6.7.1 General

The handling of palletised loads by 360° and 180° excavators (using the back-acter) can be undertaken by an attachment consisting of a pair of tined forks fitted to a carriage or frame and connected to the excavator's dipper arm in place of the bucket, usually via a quick-hitch coupler. **The use of forks on excavators should be undertaken with great care as the risks associated with this activity are significantly greater than with machines specifically designed for handling unit loads such as forklifts and telehandlers (see 3.5).**

NOTE: 180° excavators can be equipped with foldable forks as an accessory to the front loader bucket, or a purpose-built fork attachment can be fitted directly to the front loader arms. In each case, this section does not apply as operational requirements are equivalent to standard forklift operations.

6.7.2 Keeping the forks level

As with all lifting operations, 360° and 180° excavators were not primarily designed for the use of this type of attachment and a number of factors can affect safe operation. The levelling of the attachment is controlled directly by the bucket ram which, unlike purpose-designed machinery such as telescopic handlers, does not self-level. Due to this lack of self-levelling, the operating arc of the boom and dipper arm during use affects the ability to maintain horizontal positioning of the forks, meaning that the operator needs to make constant adjustments and corrections to the bucket hydraulic service to maintain a slight-tilt back of the forks at all reaches and heights. Failure to do so can result in the load becoming unstable or sliding from the forks. Additionally, the fast slewing capabilities of excavators can radically destabilise a load if care is not taken.

6.7.3 Operator competence

Handling loads with this type of attachment requires a high level of skill from the operator who should be experienced with operating 180° or 360° excavators before using this type of attachment. Specific training for this activity must be undertaken coupled with ongoing assessment during the early stages of use. Training and certification schemes generally do not incorporate fork attachments in basic training programmes.

6.7.4 Rated capacity

Operational information from the attachment manufacturer must specify the maximum rated capacity of the forks at the designated load centre. If the load centre of the load exceeds that of the attachment, the rated capacity must be reduced. The rated capacity

of the attachment does not override the machine's lifting capacity and the weight of each load must not exceed the machine's maximum rated capacity for reach and height. As with all lifting operations, where the rated capacity of the excavator is not known for reach and height, the machine should not be used for lifting operations.

6.7.5 Quick hitches

The majority of fork attachments are connected to the machine using a quick hitch. Unintentional disconnection of attachments connected by these couplers has occurred for which actions and precautions need to be taken when fitting. The dangers of and fitting procedures are further outlined in Strategic Forum for Construction guidance on the Safe Use of Quick Hitches (see **Annex G**).

6.7.6 Pre-use checks

Full checks must be carried out on the attachment prior to use, with particular emphasis on checking for cracks on each fork - particularly at the heel, and that they are straight. Bent forks are weak and as they may not be parallel, can cause damage to the pallet or load when being inserted.

6.7.7 High level load placing

Before work, the operator should position the attachment from minimum to maximum reach and height ensuring that the forks are able to be kept horizontal - which becomes the working range. When placing loads in high places at the extremities of the machine's operating reach and/or height, the operator must consider the ability to safely retrieve the forks from the pallet or load. As the risk of load instability is high in all situations, an exclusion zone around the machine and load placing area, along with an additional safety zone in case of load collapse, must be in place before operations start.

6.7.8 Fork spacing

The forks should be spaced so that the load is equally supported and that the forks are equidistant on the carriage so that the centre of gravity of the load remains mid-point to the boom. Forks that are spaced too narrow may allow the load to sag outwards whilst forks that are spaced too wide may allow the load to sag in the centre; both situations can cause instability of the load. When being repositioned, the forks should be locked to the carriage or frame, otherwise the forks may slide to one side causing the centre of gravity to be outside of the machine's centreline, instigating potential machine and load instability.

6.7.9 Heeling the load

Loads when carried on the forks need to be heeled against the carriage or frame, with the carriage/frame slightly tilted back to stabilise the load. Undercutting (where the load is not heeled against the carriage/frame) is only allowed for a) the retrieval or final placing of loads where space for the forks or carriage/frame is limited, or b) where the load or pallet - stacked closely against other loads - is smaller than the length of the forks. Only loads that are secure on a pallet or designed to be lifted using forks should be lifted.

6.7.10 Travelling with a load on the forks

A suspended load, when being travelled by a tracked 360° excavator, means some of the travelling and directional movements are absorbed by the suspended action. However, with a fork-mounted load, the traveling and directional forces are transmitted directly from the chassis to the load, increasing the risk of load instability. Travelling with a palletised load should not be attempted but should be undertaken by the correct machine for the application e.g. telescopic handler. As with suspended loads, 180° excavators should not travel with a load fitted to the back-acter.

6.7.11 Use of lifting accessories with forks

Lifting accessories should not be hung from the forks, and they are not designed to apply a force directly to an object or structure as damage such as bending of the fork can occur. Where a tilt rotator is fitted, this may aid the retrieval of a load which is not on a level surface but the working angles of the tilt rotator can further compound the load to be out of horizontal which can cause instability.

6.8 *Self-slinging*

The self-slinging of loads may be undertaken by the excavator operator in certain circumstances for basic lifts if the risk assessment indicates that it is safe to do so (See 5.3).

6.9 *Isolation of controls*

All 360° excavators are fitted with a means of isolating the controls to avoid unintentional operation and as a consequence, unintended movement. When lifting with excavators, the load and lifting accessories need to be attached to and detached from the lifting attachment by the slinger/signaller putting them at risk of being struck by the dipper, quick hitch or bucket. It is therefore essential that before anyone enters the machine's operating area that **all** the machine's controls are isolated and not re-engaged until all personnel have moved to a safe distance.

Further guidance on this topic is given in the Strategic Forum for Construction - Plant Safety Group *Reducing Unintended Movement of Plant - Good Practice Guide* (see Annex I).

6.10 *Machine operational modes for lifting operations*

Many 360° excavators and some 180° excavators are now fitted with selectable operational modes for a varying number of working activities including heavy excavating work, grading, economy, lifting operations etc. Selecting a particular mode adjusts hydraulic oil flow, pressure, control response and circuit priority for specified hydraulic circuits. These settings have been pre-set by the manufacturer and for lifting duties, oil flow is reduced within particular circuits to allow decreased movement speeds of activated components (cylinders, motors etc.), allowing the operator greater control, which increases accuracy and provides more controlled movements of a load. This in turn reduces the risk of inaccuracy, minimising potential incidents and accidents.

As part of the familiarisation process, operators should understand the modes available, how they impact upon the operation on the machine and select the most suitable mode for the work activity. Advancements in electronic controlling of hydraulic services allows tailored settings to be produced for specific attachments or activities, and should be utilised to allow effective control by the operator for the hydraulic circuits used for lifting activities.

Where a machine is not fitted with selectable operational modes, the engine speed should be reduced during lifting operations to reduce oil flow, allowing the operator greater control and minimising the risk of over-speeding a service. This can reduce or limit inaccurate operation by the operator. Some manufacturers provide a decal in the cab giving suggested engine speeds for particular activities.

6.11 *Blind lifting*

A blind lift is a lifting operation where at any point in time during the operation the excavator operator cannot directly see the load. Blind lifts should be kept to a minimum but where they are unavoidable additional signaller(s) or an effective means communication should be used to relay signals between the excavator operator and the slinger/signaller (see 5.2.4).

6.12 Pick and carry duties

Lifting a suspended load with an excavator and travelling with the load before lowering, is significantly more hazardous than lifting and lowering with the excavator stationary on a firm level surface. The following guidance should be taken into account when planning a lifting operation involving travelling with a suspended load.

The majority of excavators are not provided with load charts for lifting and travelling with suspended loads. Where a load chart is not provided, the advice of the excavator manufacturer should be sought and recorded in a retrievable format. If advice from the manufacturer is not forthcoming, the excavator should be de-rated by a suitable factor of not less than two, to take account of dynamic loads, load swing and slopes.

When travelling with a suspended load, the following points should be adhered to:

1. The booms and load should be kept as low to the ground as practicable (load 300-500mm above the ground). To facilitate this the correct length of chains, slings etc. should be selected;
2. It is essential that the load radius remains within that allowed by the load chart for the magnitude of the load being lifted;

NOTE: *In the absence of a manufacturer's load chart for travelling with a suspended load the de-rated load radius should not be exceeded.*

3. Visibility may well be reduced and planning should identify appropriate control measures, such as a marshaller to guide the operator;
4. Any load swing must be minimised by delicate use of controls and slow travel speeds;
5. Operators should take care when braking and / or turning as this creates dynamic forces transmitted to the boom, thereby reducing stability;
6. Plant marshalls, slinger/signallers and other personnel should never walk in front of the excavator to steady a swinging load as it is very easy to trip, fall and be crushed by the excavator tracks or wheels;

NOTE: *Additional training may be required by slingers when load handling a suspended load, particularly for pick-and-carry duties.*

7. The machine should travel extremely slowly and never above walking pace;
8. The operator should follow the manufacturer's instructions for travelling on slopes and inclines. It is essential that they do not attempt to climb, descend or cross inclines in excess of manufacturer's limiting values for travelling with a suspended load, as this significantly increases the likelihood of overturning;
9. Lightweight but bulky items like roof trusses and shuttering pose a special risk. Although relatively light, they are physically large, leading to large dynamic forces and are significantly affected by the wind. Physical restrictions on-site may require the booms to be elevated in order to clear fixed obstructions. Any carrying and placing of such items with an excavator carries significant extra risk that must be addressed by the site risk assessment;
10. Care should be taken to avoid overhead obstructions including overhead power lines (see 7.4.6);
11. Where possible reversing should be avoided whilst travelling with a load.

6.13 Lifting alongside railways

For lifting operations, including simple and intermediate lifts, adjacent to open railways the Principal Contractor or other lead organisation should make contact with the relevant asset protection team for that railway route. Details available at: <http://www.networkrail.co.uk/wp-content/uploads/2016/11/Asset-Protection-national-contacts.pdf>

6.14 *Lifting alongside highways and other sites of exceptional hazard*

The use of lifting equipment, including excavators, during construction activities on or adjacent to sites of exceptional hazards, such as highways, chemical plants and nuclear installations, requires particular attention during planning, set-up, use, maintenance and dismantling. If the excavator or its load falls onto high-hazard areas within the site, a catastrophic accident might result with multiple fatalities or long-lasting environmental issues.

Detailed guidance is given in **Annex E** of BS 7121-1:2016.

6.15 *Lifting accessories*

Lifting accessories are at risk of failure from the following:

- The WWL of the lifting accessory being exceeded;
- Shock loading e.g. dynamic loads during pick and carry;
- The lifting accessory becoming weakened due to physical damage or wear.

A particular risk is pinch point failure which occurs when lifting accessories do not hang freely suspended and pinch against other equipment. This may cause the forces in components to be magnified and overload the component. Both the load and the lifting accessories connecting it to the hook should always hang freely, thus ensuring that no part of any lifting accessory bears on any part of the lifting equipment at any time.

Catastrophic failure of lifting accessories often occurs quite suddenly and without warning or gradual component degradation with surface deformation or flattening of metal surfaces.

Lifting accessories exposed to shock loads during pick and carry duties on an excavator should not be used on other lifting equipment such as mobile or tower cranes due to the increased risk of failure.

6.16 *Guiding loads*

When guiding loads the use of push pull poles should be considered in preference to tag lines. These telescopic poles can, as their names suggests, be used for both pulling and pushing when rotating or positioning a load. Use of these poles reduces the need for hand contact with the load thereby reducing the risk of entrapment.



Figure 18 – Push-pull Pole

7.0 Maintenance and Inspection

7.1 General

The effective maintenance of an excavator is an essential part of safe operation, including lifting operations. The following guidance relates to both earthmoving and lifting duties. As with all machines an excavator wears, deteriorates and can suffer damage over time. The maintenance process, including checks and inspections, monitors, prevents and rectifies this deterioration. It is important that the personnel asked to carry out these tasks have the necessary machine-specific training, experience and competence in both periodic and breakdown maintenance.

Both the user and owner of the excavator, and any attachments used with it, have a responsibility to ensure that they are maintained in a safe working condition. In practice the maintenance, other than pre-use checks, is normally undertaken by the excavator owner.

Excavators require the manufacturer's preventative maintenance instructions to be strictly complied with, if safety is to be maintained in use. Checks and inspections should be carried out taking account of the frequency of use of the excavator and the environmental conditions in which it regularly works. Checks should be carried out more frequently where the excavator is used regularly for lifting operations. If the operator is considered to be competent to carry out routine pre-use and weekly checks, they may be authorised to do so.

The employer of the person carrying out these checks should ensure that the machine is taken out of use for the period of time required to carry them out. Also, the employer or authorized person carrying out the checks should ensure that a safe system of work is in place to prevent personnel from being exposed to risk, for example from the inadvertent operation of the equipment.

Basic checks and inspections should be carried out in accordance with company instructions and the manufacturer's recommendations:

- Pre-use Checks - these are carried out prior to each use of the machine and include checks for damage and correct functioning of the excavator (See list in **Annex E**).
- Weekly Inspections - these are additional inspections to the pre-use checks.

These checks and inspections should be recorded.

If there is a defect that affects the safe operation of the excavator, it must be reported and the machine taken out of service immediately. If it does not affect the immediate safe operation of the excavator, the defect should be reported to the supervisor so that repairs may be carried out in a timely manner.

7.2 Reporting of Defects

There must be provision for the operator(s) of excavators to make written reports of defects or observations immediately they are identified. If a defect is safety critical, the machine should not be used until the defect has been rectified.

The written report should be to a pre-defined format, (a company pro-forma, a section on the daily time sheet, etc.), which requests details of the defect or observation and supporting information such as date, time, excavator identification, circumstances, etc., and must be reported at least daily. '*Nil Reports*' must also be submitted at least weekly.

All the defect reports, including the '*nil reports*', should be forwarded to the excavator owner, (or the delegated person), who is in a position to make an informed decision

about a planned response to the report. A copy of the original report should be retained by the operator.

Once the defect / observation has been responded to and cleared, this should then be recorded with supporting information on the original defect report.

The '*un-cleared*' and '*cleared*' reports should be securely lodged within the excavator owning company's maintenance management system and must be made accessible on demand to the operators of the excavator as well as other authorised bodies.

7.3 *Precautions*

Extreme care must be taken when carrying out maintenance procedures on excavators. Maintenance personnel should never stand under a suspended load or raised equipment as the load or equipment could fall or tip. If work has to be carried out under a raised boom, suitable scotches or supports must be put in place before access is gained.

Care should be taken when working on the hydraulic system to ensure that hydraulic systems are depressurised. Even with the excavator's engine switched off, the hydraulic system may still be pressurised, consequently the replacement or repair of hydraulic hoses or fittings should be approached with extreme caution.

7.4 *Modifications*

Excavators should not be modified without the express written permission of the excavator manufacturer. Unauthorised modifications will affect the warranty, invalidate the CE marking and may compromise safety.

7.5 *Scheduled Lubrication*

Operators may be required to carry out lubrication of certain items, such as the greasing of sliding parts, at specified intervals. They should only undertake such tasks if they are competent to do so and should be provided with the necessary equipment and instructions to carry this out safely.

7.6 *Scheduled Maintenance*

It is the responsibility of the site management to ensure that all excavators are adequately maintained in efficient working order and in a state of good repair.

A scheduled preventative maintenance program helps to meet these requirements. The frequency at which the maintenance activities are carried out must take into account the machine usage and the working environment. A record of maintenance should be kept for each excavator.

Where an excavator is hired out on the basis that the owner is responsible for carrying out maintenance, the owner should inform the hirer, at the start of the hire, that their maintenance staff will require access to the machine at specified intervals. The hirer should be advised of the frequency and length of time required for maintenance operations.

7.7 *Breakdowns*

Breakdowns should be minimised by adequate inspection and preparation of the excavator prior to delivery on site. Repairs on site should only be undertaken following a thorough job and site-specific risk assessment and the implementation of a safe system of work, including inspection of the work following completion.

7.8 Maintenance Records

Comprehensive maintenance records are essential to the safe, efficient and economical operation of excavator. They provide a complete “cradle to grave” history of the individual excavator giving the following benefits:

- evidence of adequate maintenance as part of the management system;
- establishing breakdown trends over time and providing information for the review of maintenance frequency;
- identification of component failure trends for feedback to the manufacturer;
- evidence of adequate maintenance to the Enforcing Authorities in the event of an incident;
- enabling the performance of the excavator to be reviewed over time to inform future purchases.

7.9 Maintenance Record Format

Maintenance records can be kept in either paper or electronic format. Paper records are often easier to update as the input will often be in paper format such as inspection reports or work sheets. Electronic records are however more secured against loss and damage, and the data is more readily analysed. There are many maintenance record software packages on the market but care should be taken when considering purchase to ensure that the system is flexible enough to accommodate changes in types of input and output.

7.10 Replacement Components

Replacement components should be in accordance with the excavator manufacturer's specifications.

7.11 Tyre Maintenance, Repair and Replacement

Tyre pressure and condition should be checked regularly and in accordance with manufacturer's instructions.

Additional advice on tyre maintenance, repair and replacement is given in **Annex H**.

7.12 Actions in the Event of Defects and Breakdowns

All defects that make the excavator unsafe for use should be recorded and reported immediately to both the excavator owner and site's appropriate representative (such as service manager, site manager, or supervisor), and the excavator should be taken out of service. Steps should be taken to ensure that the excavator cannot be used before repairs have been completed. All other defects should be recorded and reported as soon as possible.

It is essential that repairs or adjustments are only carried out by authorised persons. Once any defects and breakdowns have been rectified, the person carrying out the work should sign the defect report to indicate that rectification has taken place.

7.13 Further Guidance

Further detailed guidance on the maintenance and inspection of excavators is given in:-

- BS 7121-2-1:2012, *Code of practice for the safe use of cranes Part 2-1: Inspection, maintenance and thorough examination – General*
- **Annex I.**

8.0 Thorough Examination

The Lifting Operations and Lifting Equipment Regulations 1998 (LOLER) require that all lifting equipment is thoroughly examined by a competent person at specified intervals.

An excavator used for object handling is regarded as lifting equipment and requires thorough examination by a competent person at least every 12 months. (See LOLER Reg. 9). An excavator which is never used for object handling (for example, because it is not equipped with a load hooking device) does not require thorough examination but still requires regular inspection under PUWER, which will be to a similar standard.

Front end loaders, not modified or adapted for lifting operations, do not require thorough examination under LOLER, but still require regular inspection under PUWER. If the loader is used for object handling it will require thorough examination under LOLER at least every 12 months.

A report of thorough examination of lifting equipment is not required where the employer has an EC Declaration of Conformity dated within the last 12 months and the excavator has not been modified in any way. If however the machine has been modified, for example by the fitting of a quick hitch, a thorough examination will be required at the time of modification.

Where a quick hitch is fitted:

- All quick hitches suitable for lifting (fitted with a lifting eye) that remain permanently fitted to a machine are to be thoroughly examined at the same time as the base machine (normally a maximum interval of 12 months);
- All quick hitches suitable for lifting (fitted with a lifting eye) which are regularly removed from the machine (as interchangeable equipment) are subjected to a periodic thorough examination at intervals not exceeding six months.

All quick hitches subject to thorough examination must be permanently marked with a unique identification number. If a quick hitch does not have such a number, the owner/user must ensure that one is applied.

Slings, loose hooks, chain slings, polyester slings, shackles etc. are classed as lifting accessories and must be thoroughly examined at least every 6 months.

Buckets with integrated hooks/lifting eyes are also classed as lifting accessories and should be thoroughly examined at least every 6 months.

NOTE: Hooks/lifting eyes directly attached to the bucket are susceptible to damage during earthmoving operations and are unsuitable for lifting operations.

Where periodic thorough examinations are carried out, it is incumbent on the competent person to set the date of the next thorough examination. This is generally six or twelve months from the date of the thorough examination, but should be reduced by the competent person where they judge that the rate of deterioration of the lifting equipment may lead to a dangerous situation occurring before the next thorough examination, if it were made at the maximum interval. Examples of this are where an excavator:

- Is being used in a corrosive environment such as a petrochemical plant or close to the sea;
- Is being used more frequently than normal i.e. double shifting;
- Is always lifting loads at or near the rated capacity;
- Has components that are wearing rapidly and require frequent replacement.

The results of any thorough examination must be reported in accordance with Regulation 9 of LOLER and contain the details specified in Schedule 1.

NOTE: Regulation 10(1) (c) of LOLER requires that where, in the opinion of the competent person, there is a defect in the lifting equipment involving an existing or imminent risk of serious personal injury, send a copy of the report must be sent as soon as is practicable to the relevant enforcing authority.

Thorough examinations should be carried out by competent persons who are sufficiently independent and impartial.

8.1 Thorough Examination of Lifting Accessories and Lifting Attachments

LOLER requires that lifting accessories and lifting attachments are thoroughly examined at intervals not exceeding six months.

8.2 Responsibility for Thorough Examination

LOLER is very clear that the responsibility for ensuring that the thorough examination of excavators used for lifting is carried out lies with the user of the excavator. In the case of a hired-in excavator, the actual undertaking of thorough examination is often delegated to the excavator owner by the user. The user however, retains the legal responsibility for ensuring that thorough examinations are carried out.

NOTE: *The user is the employer carrying out tasks with the excavator. The excavator may be from the user's own fleet or may have been hired from a hire company.*

8.3 Further guidance

Further detailed guidance on the thorough examination of excavators is given in:-

- BS 7121-2-1:2012, *Code of practice for the safe use of cranes Part 2-1: Inspection, maintenance and thorough examination – General*
- L113 *Safe Use of Lifting Equipment - Lifting Operations and Lifting Equipment Regulations 1998 Approved Code of Practice and Guidance (Second Edition) Published 2014 - ISBN 978 0 7176 6586 0*
- **Annex I.**

Annex A – Non-exhaustive List of Hazards for Lifting with Excavators

A.1 Load Hazards

Load hazards include:

- a. Overloading – degree of certainty of accuracy of load mass;
- b. Effect of offset centre of gravity - degree of certainty of accuracy of position;
- c. Live loads - moving centre of gravity (e.g. tanks partially filled with liquid);
- d. The stability of the load when being lifted up and set down;
- e. Loads subject to environmental influence - e.g. loads with a large wind area in relation to their mass, or loads that can increase, e.g. due to water ingress e.g. due to rain/snow;(note wind loads can cause sudden movements and apply a force in the direct of the wind);
- f. Load swing – e.g. during slewing and travelling;
- g. Overloading and sudden movement – e.g. adhesion between the load and its support and any other forms of resistance to lifting;
- h. Lifting accessory failure – e.g. sharp edges on load;
- i. Load failure – e.g. insecure slinging of multiple loads e.g. scaffold tubes.

A.2 Lifting Equipment Hazards

Lifting Equipment hazards include:

- a. Crushing – e.g. excavator capable of rapid motions;
- b. Crushing – e.g. persons in machine operating zone;
- c. Overloading – e.g. reduced capacity during pick and carry duties;
- d. Structural failure – poor maintenance, inspection and thorough examination;
- e. Overturning – poor ground conditions;
- f. Overturning – overload (static and dynamic);
- g. Visibility restrictions;
- h. Failure of lifting equipment with suspended load.

A.3 Environmental Hazards

Environmental hazards include:

- a. Wind, rain, snow, ice, mist, fog and lightning;
- b. Overhead hazards such as power cables, pipe gantries, other cranes, plant and structures;
- c. Underground hazards such as buried services, voids, basements and cellars;
- d. Inadequate ground bearing capacity for loads imposed by the lifting operation;
- e. Working on or alongside water;
- f. Sites of exceptional hazard such as railways, chemical plants and nuclear installations.

Annex B – Case Studies Illustrating Lift Category

Study 1 - Changing Environmental Complexity with Constant Load Complexity

Example Activity – Lifting of Pre-cast Concrete Units with an Excavator

Situation 1		A concrete panel is to be lifted from the ground and is to be placed at ground level in a new location. The lift involves the excavator working at minimum radius with the load being 30% of maximum rated capacity at that radius and is to be slewed through 70 degrees.	
Example Hazards	Example Control Measures	Lifting Team	Planning Requirements
Overturning of excavator or failure through overloading of the excavator, attachment or lifting accessories	Accurately assess weight and max radius of load Selection of excavator and lifting accessories	<ul style="list-style-type: none"> Appointed person prepares generic RA & MS Slinger/signaller takes role of lift supervisor and slinger/signaller 	<ul style="list-style-type: none"> Generic Risk Assessment and Method Statement Onsite review of RA and MS by lift supervisor
Overturning of excavator through ground bearing failure	Assessment of ground conditions and appropriate load reduction or ground improvement measures		
Lift Categorisation (see 3.4 and Figure 3)			
Complexity Index			
Environment - 1		Load/lifting Equipment - 1	
Lift Category - Basic			

Situation 2		A concrete panel is to be lifted in into position, and handled by slinger/signaller who can only be positioned adjacent to the load and will be out of the excavator operator's line of sight. The lift involves the excavator working at 50% of maximum radius with the load being 60% of maximum rated capacity at that radius and is to be slewed through 45 degrees.	
Example Hazards	Example Control Measures	Lifting Team	Planning Requirements
Overturning of excavator or failure through overloading of the excavator attachment or lifting accessories	Accurately assess weight and max radius of load Selection of excavator and lifting accessories	<ul style="list-style-type: none"> Appointed person prepares task and/or site-specific RA & MS Slinger/signaller takes role of lift supervisor and slinger/signaller 	<ul style="list-style-type: none"> Task and/or site specific Risk Assessment and Method Statement Onsite review of RA and MS by the lift supervisor
Overturning of excavator through ground bearing failure	Assessment of ground conditions and appropriate load reduction or ground improvement measures		
Crushing or striking of personnel guiding load	Slinger/signaller situated adjacent to landing area with agreed system of signalling (radio as line of sight obscured)		
Lift Categorisation (see 3.4 and Figure 3)			
Complexity Index			
Environment - 2		Load/lifting Equipment - 1	
Lift Category - Intermediate			

Situation 3			
A concrete duct is being lifted into a trench where there are overhead lines above, and will need to be handled by a slinger/signaller who can only be positioned adjacent to the load. The lift involves the excavator working at 60% of maximum radius with the load being 60% of maximum rated capacity at that radius and is to be slewed through 90 degrees. The depth of the trench is 2.3 metres and the lift will be performed under floodlight conditions.			
<i>Example Hazards</i>	<i>Example Control Measures</i>	<i>Lifting Team</i>	<i>Planning Requirements</i>
Overturning of excavator or failure through overloading of the excavator attachment or lifting accessories	Accurately assess weight and max radius of load Selection of excavator and lifting accessories	<ul style="list-style-type: none"> Appointed Person prepares site specific RA & MS Separate lift supervisor oversees lifting operation Separate Slinger/signaller required Appointed person present on the site during lift, unless they select a competent deputy to attend in their place. 	<ul style="list-style-type: none"> Site specific Risk Assessment and Method Statement Onsite review of RA and MS by the lift supervisor and appointed person/deputy
Overturning of excavator through ground bearing failure	Assessment of ground conditions and appropriate load reduction or ground improvement measures		
Crushing or striking of personnel guiding load	Slinger/signaller situated adjacent to landing area with agreed system of signalling (radio if line of sight obscured)		
Overhead lines -electric shock	Isolate power lines		
Lift Categorisation (see 3.4 and Figure 3)			
Complexity Index			
Environment - 3		Load/lifting Equipment - 1	
Lift Category - Complex			

Study 2 - Changing Load Complexity with Constant Environmental Complexity

Example Activity – Lifting a Tank with an Excavator

<p>Situation 1</p> <p>A symmetrical empty tank of a known weight is to be lifted from ground level and placed back at ground level. The lift involves the excavator working at 30% of maximum radius with the load being 45% of maximum rated capacity at that radius and is to be slewed through 110 degrees. The load will be placed close to the excavator.</p>			
<i>Example Hazards</i>	<i>Example Control Measures</i>	<i>Lifting Team</i>	<i>Planning Requirements</i>
Overturning of excavator or failure through overloading of the excavator, attachment or lifting accessories	Accurately assess weight and max radius of load Selection of excavator and lifting accessories	<ul style="list-style-type: none"> Appointed person prepares generic RA & MS Slinger/signaller takes role of lift supervisor and slinger/signaller 	<ul style="list-style-type: none"> Generic Risk Assessment and Method Statement Onsite review of RA and MS by lift supervisor
Overturning of excavator through ground bearing failure	Assessment of ground conditions and appropriate load reduction or ground improvement measures		
Lift Categorisation (see 3.4 and Figure 3)			
Complexity Index			
Environment - 1		Load/lifting Equipment - 1	
Lift Category - Basic			

<p>Situation 2</p> <p>An unsymmetrical empty tank of a known weight is to be lifted from the bed of a delivery vehicle and placed at ground level. The lift involves the excavator working at 70% of maximum radius. The weight of the load is 30% of maximum rated capacity at that radius, has a large surface area and is to be slewed through 110 degrees.</p>			
<i>Example Hazards</i>	<i>Example Control Measures</i>	<i>Lifting Team</i>	<i>Planning Requirements</i>
Overturning of excavator or failure through overloading of the excavator attachment or lifting accessories	Accurately assess weight and max radius of load Take account of large wind area and reduce rated capacity if required Selection of excavator and lifting accessories	<ul style="list-style-type: none"> Appointed person prepares task and/or site-specific RA & MS Slinger/signaller takes role of lift supervisor and slinger/signaller Additional Signaller required 	<ul style="list-style-type: none"> Task and/or site specific Risk Assessment and Method Statement Onsite review of RA and MS by the lift supervisor and the appointed person/deputy
Overturning of excavator through ground bearing failure	Assessment of ground conditions and appropriate load reduction or ground improvement measures		
Crushing or striking of personnel guiding load	Slinger/signaller situated adjacent to landing area with agreed system of signalling (radio if line of sight obscured)		
Lift Categorisation (see 3.4 and Figure 3)			
Complexity Index			
Environment - 1		Load/lifting Equipment - 2	
Lift Category - Intermediate			

Situation 3		A ½ full tank is to be lifted from a trench and placed at ground level. The lift involves the excavator working at 90% of maximum radius with the load being 84% of maximum rated capacity at that radius and is to be slewed through 110 degrees.	
<i>Example Hazards</i>	<i>Example Control Measures</i>	<i>Lifting Team</i>	<i>Planning Requirements</i>
Overturning of excavator or failure through overloading of the excavator attachment or lifting accessories	Accurately assess weight and max radius of load Selection of excavator and lifting accessories	<ul style="list-style-type: none"> Appointed Person prepares site specific RA & MS Separate lift supervisor oversees lifting operation Separate Slinger/signaller required Appointed person present on the site during lift, unless they select a competent deputy to attend in their place 	<ul style="list-style-type: none"> Site specific Risk Assessment and Method Statement Onsite review of RA and MS by the lift supervisor
Overturning of excavator through ground bearing failure or collapse of ground adjacent to trench	Assessment of ground conditions and appropriate load reduction or ground improvement measures		
Crushing or striking of personnel guiding load	Slinger/signaller situated adjacent to landing area with agreed system of signalling (radio if line of sight obscured)		
Lift Categorisation (see 3.4 and Figure 3)			
Complexity Index			
Environment - 1		Load/lifting Equipment - 3	
Lift Category - Complex			

Annex C - Example of a Checklist for Lift Planning

Item	Requirement	Yes (✓)	No (✓)	N/A (✓)
1.	Has the person carrying out the planning been identified and appointed?			
2.	Has the task been identified?			
3.	Will the task involve travelling with the suspended load (pick and carry)			
4.	Is the weight and centre of gravity of the load accurately known?			
5.	Is the load stable when being lifted and set down?			
6.	Is the radius and height of the lift known?			
7.	Has the excavator been selected?			
8.	Is it the most suitable type of lifting equipment for the task?			
9.	Has the method of slinging, the lifting accessories required and their weight been identified?			
10.	Has the ground on which the excavator will stand been assessed?			
11.	Have any environmental hazards including overhead lines, roads and railways, been identified and assessed?			
12.	Has a risk assessment been carried out and recorded?			
13.	Have the risks identified been assessed and control measures identified to eliminate the risks or reduce them to an acceptable level?			
14.	Has a safe system of work been developed and recorded in a lift plan			
15.	Have arrangements been put in place to control access to the area in which the lift will take place?			
16.	Does the safe system of work include a requirement for the operator to isolate the excavator's controls when the slinger/signaller is attaching or detaching the load?			
17.	Have the composition, competencies and members of the lifting team been identified, including effective communication taking account of language differences between members of the lifting team?			
18.	Have arrangements been made for the lift plan to be briefed to the lifting team?			
19.	Has the excavator been effectively maintained?			
20.	Do the excavator and lifting accessories have current reports of thorough examination?			
21.	Has the management of change been considered i.e. the need for any deviations from the plan or site changes to be referred back to the Appointed Person before the lifting operation proceeds?			

Annex D - Example of a Checklist for Familiarisation

Excavator Familiarisation Handover Checklist	No.
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Issuing Depot:	Date:
Handover By:	Fleet No.
Machine Type:	
Customer:	

Operation of controls	✓	Maintenance	✓
Safety lever	<input type="checkbox"/>	Daily and weekly checks as manual	<input type="checkbox"/>
Travel forward/reverse	<input type="checkbox"/>	Location of items to be checked inc.	<input type="checkbox"/>
Steer right/left, counter rotate	<input type="checkbox"/>	Fuel	<input type="checkbox"/>
Boom up/down	<input type="checkbox"/>	Hydraulic oil	<input type="checkbox"/>
Dipper up/down	<input type="checkbox"/>	Engine oil	<input type="checkbox"/>
Bucket crowd	<input type="checkbox"/>	Batteries	<input type="checkbox"/>
Slew left/right	<input type="checkbox"/>	Coolant	<input type="checkbox"/>
Stabilizer legs (if fitted)	<input type="checkbox"/>	Screen wash reservoir	<input type="checkbox"/>
Blade or loader bucket (if fitted)	<input type="checkbox"/>	Documentation/equipment	
Overload warning unit	<input type="checkbox"/>	Manufacturer's operating manual	<input type="checkbox"/>
Auto idle	<input type="checkbox"/>	Load charts	<input type="checkbox"/>
Power mode	<input type="checkbox"/>	Thorough examination report	<input type="checkbox"/>
Horn	<input type="checkbox"/>	Operator's record book	<input type="checkbox"/>
Wiper	<input type="checkbox"/>	EC conformity certificate	<input type="checkbox"/>
Lights	<input type="checkbox"/>	Approved lifting point	<input type="checkbox"/>
Stop button	<input type="checkbox"/>	Grease gun/tyre pressure gauge	<input type="checkbox"/>
Engine isolation switch and key	<input type="checkbox"/>	Comments	
Use and configuration of visibility or other aids	<input type="checkbox"/>		
	<input type="checkbox"/>		
	<input type="checkbox"/>		
I, the undersigned, acknowledge that I have been familiarised with the above controls and checks.			
Name (print)		Signature	
Company		Date	

Annex E - Example of Daily (pre-use) Checks

Operator's Excavator Pre-Use Check Sheet

Operator's Name:	Date:
Excavator Make:	Model:
Motive Power:	Attachments:
Operator's Signature:	

<i>Item</i>		<i>OK</i> (✓)	<i>N/A</i> (✓)	<i>Defect Reported</i>
Visual Pre - start Check or "walk-around."				
1.	Verify location of handbook and confirm machine has a current report of Thorough Examination			
2.	General condition and cleanliness, including cab			
3.	Evidence of any oil leaks (include hydraulic cylinders, fittings, valves and track/wheel hubs)			
4.	Attachments, (completeness, damage, decals, rated capacity, fastenings)			
5.	Quick hitch fittings (if applicable)			
6.	Boom, dippers, pins and joints			
7.	Approved lifting point			
8.	Tracks - shoes, rollers, sprockets, idlers, track links			
9.	Wheels (bent rims and nut security) & tyres (worn tread, cuts and damage to side walls and tread)			
10.	Tyre pressure (check using gauge)			
11.	Hydraulic hose and pipe condition and security			
12.	Cab condition, ROPS/FOPS mounting			
13.	Cab windows, including roof section, to be clean.			
14.	Cracked/unauthorised welding			
15.	Guards, cowlings and fasteners			
16.	Decals/labels, including manufacturer's rating plate			
17.	Fire extinguisher, if fitted, (in-date, charged?)			
18.	Manufacturer safety bars			
19.	Lights/Mirrors / CCTV/other vision aids			

<i>Item</i>		<i>OK</i> (✓)	<i>N/A</i> (✓)	<i>Defect Reported</i>
Physical Check of lubricants and fluids. (wearing gloves)				
20.	Engine oil			
21.	Transmission oil			
22.	Coolant			
23.	Battery(ies)			
24.	Brake fluid			
25.	Hydraulic oil			
26.	Fuel inc additives (AdBlue etc.)			
27.	Fan belt deflection			
28.	Air filter indicator			
29.	Visual check of all engine components			
Running Checks				
30.	All controls for correct function, including safety lever			
31.	All gauges and instruments including horn and hour meter			
32.	All lights/indicators including beacon			
33.	Heater, defroster and wipers for correct function			
34.	Verify seat position and seat belt function			
37.	Any unusual noises			
39.	Stabilizers /360° rotation. (as appropriate)			
40.	Load charts			
41.	Rated capacity overload warning device			
42.	Rated capacity indicator/limiter (if fitted)			
43.	All warning devices must be operational			
NOTE: All pre-use checks must be carried out in accordance with the specific instructions published in the relevant manufacturer's operating handbook.				

Annex F - Key Points for Excavator Operators - Lifting and Travelling with Suspended Loads

- You have personal and legal responsibility to use all excavators safely. Serious misuse of excavators may well be treated as gross misconduct which could well lead to dismissal or individual prosecution;
- If it is not safe to start work - **Inform your supervisor**;
- If it is not safe to carry on working - **Stop and inform your supervisor**;
- Always follow the excavator or attachment manufacturer's instructions.

Before Starting

- You must be trained and authorised to lift and travel with suspended loads
- You must have been familiarised with the specific make and model of excavator
- You must ensure that you are totally conversant with the excavator manufacturer's guidance on deactivating the hydraulics by using the "Deadman"
- Verify with your supervisor that the excavator, lifting attachments and lifting accessories have a current thorough examination report and has been suitably maintained
- Carry out daily checks, including safety devices and lifting accessories before starting your shift according to the operator's manual
- Report all defects to your supervisor and do not put the machine to work if there are defects
- Ensure you have been briefed by your supervisor on the task, hazards, control measures (including designated exclusion zones) and site conditions that may affect the safe operation of the excavator. You should be given a copy of the lift plan or method statement for the task
- Ensure that you are comfortable with carrying out the task
- Ensure you have had authorisation from your supervisor to carry out the task
- Inform the slinger/signaller that they must stay clear of the moving path of your machine, maintain regular eye contact with you and work to an agreed code of signals
- Wear your seat belt at all times to reduce the risk of injury should the excavator overturn. **It could save your life!**
- If it is not safe to start work - Inform your supervisor.

During Use

- Ensure that you understand the excavator's limitations on the rating plate and the specific load charts for lifting suspended loads. Never overload the excavator
- Ensure that you have adequate clearance between the suspended load and the machine
- Know your site – be aware of slopes, ground conditions, visibility, pedestrians and other potential hazards that may affect the safe operation of the excavator
- Travel slowly and carefully when travelling with a suspended load
- Only travel on slopes with a suspended load if allowed by the manufacturer, check the maximum gradients and ensure that you take extreme care when on a slope with a load
- Ensure you are familiar with using and changing any attachments. You must understand the attachment's effect on the lifting capacity and the need for any derating
- Maintain regular eye contact with your slinger/signaller and stop your machine immediately if you lose sight of them
- Ensure that the hydraulics are deactivated when the slinger/signaller is hooking or unhooking the load.
- If it is not safe to carry on working - **Stop and inform your supervisor.**

After Use

- When leaving the excavator cab, park on firm, dry level ground; apply the parking brake (where relevant); remove any lifting accessories, and lower the boom/attachments
- Stop the engine, remove the ignition key and secure the machine to prevent non-authorised personnel from starting the machine
- Exit the cab safely using correct procedures

NOTE: The excavator operator's roles and responsibilities are detailed in section 5.2.3.

Annex G - Key Points for Supervisors of Excavator Operators - Lifting and Travelling with Suspended Loads

- You have personal and legal responsibility to ensure that all excavators are used safely. Serious misuse of excavators may well be treated as gross misconduct which could well lead to dismissal or individual prosecution;
- Ensure that the operator knows that if it is not safe to start work - **They must inform you;**
- Ensure that the operator knows that if it is not safe to carry on working - **They must stop and inform you;**
- Ensure that the excavator or attachment manufacturer's instructions are always followed.

Before Starting

Ensure that:

- the excavator, lifting attachments and lifting accessories have a current thorough examination report and have been suitably maintained
- the operator is trained to operate excavators when lifting and travelling with suspended loads and has been familiarised with the specific make and model of excavator they are to operate
- the excavator operator has read the manufacturer's guidance on deactivating the hydraulics by using the "Deadman."
- that daily checks, including safety devices and lifting accessories, are carried out by the operator before the start of each shift and that all defects are recorded and rectified
- site conditions are checked and that there is adequate segregation of pedestrians and plant/vehicles in place
- if the excavator is allowed to travel on slopes with a suspended load, then the maximum permitted gradient needs to be established and the operator informed
- you have briefed the operator on the task, hazards, control measures (including designated exclusion zones) and site conditions that may affect the safe operation of the excavator. You should give the operator a copy of the lift plan or method statement for the task
- the operator is comfortable with carrying out the task
- the operator has been authorised to carry out the task
- the slinger/signaller is fully briefed to stay clear of the machine's moving path at all times, maintain regular eye contact with the operator and work to an agreed code of signals.

During Use

Ensure that:

- the operator understands the excavator's limitations on the rating plate and the specific load chart for lifting suspended loads, and that they should never overload the excavator
- the operator understands the need to have adequate clearance between the suspended load and the machine
- the operator is familiar with the site and that they are aware of slopes, ground conditions, visibility, pedestrians and other potential hazards that may affect the safe operation of the excavator, including the need for extreme care when travelling on slopes with a suspended load
- regular unannounced spot checks are carried out on excavators working on site to monitor for safe working practices including that the excavator controls are isolated when the slinger/signaller is hooking up or unhooking the load and that the load is left in a safe position e.g. chocked if it can roll
- the operator wears the seat belt to reduce the risk of injury should the excavator overturn. **It could save their life!**
- the operator is familiar with using and changing any attachments
- the operator knows that they must maintain regular eye contact with the slinger/signaller and stop their machine immediately if they lose sight of them
- the operator knows that the excavator controls should be isolated whilst the load is being attached/detached.

After Use

Ensure that:

- when leaving the excavator cab, the operator has parked on level ground, lowered the boom/attachments, applied the parking brake, has switched off the engine, isolated and removed any keys.

Annex H - Tyre Maintenance, Repair and Replacement

This section applies to pneumatic tyres only. Foam filled tyres are not user serviceable.

H.1 Tyre Pressure Check

- Tyre pressures should be marked on the excavator chassis adjacent to each wheel;
*NOTE: Tyre pressure may be given in different units - pounds per square inch (psi), bar or kilo Pascals (kPa). Conversion factors are given in **Table F.1**.*
- Pressures should be checked daily when the tyres are cold;
- Tyre pressures should be the same for all tyres on the excavator and should be within +5% -0% of the manufacturers specified pressure, unless a different tolerance is specified by the manufacturer;
- Tyre pressure gauges should be of known accuracy (within +/- 1%);
- Remote tyre pressure monitoring systems are available. Before fitting third party monitoring systems it is advisable to consult the excavator manufacturer;
- Where a tyre is found to be significantly under pressure, no attempt should be made to re-inflate it and return the machine to use. It is essential that the cause is investigated by a competent tyre specialist, as this may well be an indication of imminent tyre failure;
- Where tyres are frequently found to be under pressure the cause should be investigated by a competent tyre specialist, as this may well be an indication of potential tyre failure.

	psi	bar	kPa
psi	1	0.0689	6.89
bar	14.5	1	100
kPa	0.145	0.01	1

Table F.1 - Pressure Conversion Factors

H.2 Tyre Inflation

The information in this sub-clause applies to tyres fitted on single piece wheels. For tyres fitted on multi-piece wheels see BITA Publication GN 67, *Multi-Piece Pneumatic Tyred Wheels - Inspection, Maintenance & Repairs*. Where multi-piece wheels are fitted or there is any doubt about the type of wheel, a competent tyre specialist should be consulted.

- Air should be added, if required, inflating to the pressure specified in the manufacturer's manual;
- Before starting inflation a personnel exclusion zone of at least 3m around the machine should be established by the use of barriers, cones etc. (See **Figure H.1**);
- Personnel inflating tyres should stand a minimum of 3 metres away from the tyre and outside the likely explosion trajectory to avoid injury in the event of a failure. This will require at least 3m of airline between the nozzle and airline trigger mechanism (See **Figure H.1**);

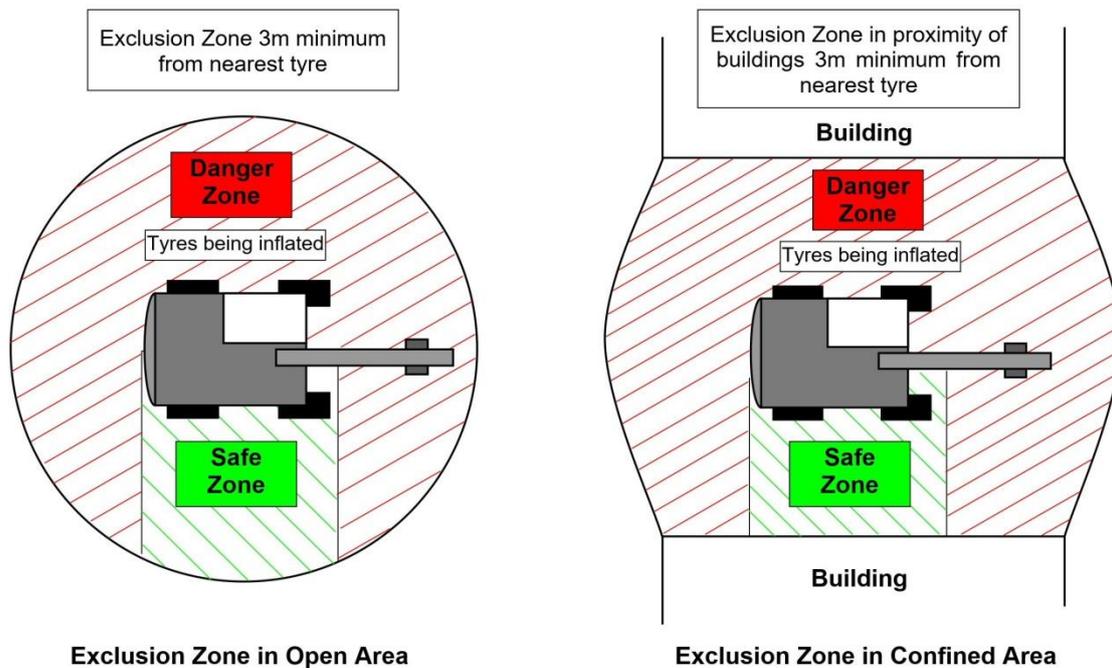


Figure H.1 - Tyre Inflation Safe Zones and Exclusion Zones

- Personnel should ensure that they stand on the other side of the excavator when inflating (See **Figure H.1**);
- Where possible the use of a restraint, such as a strong secured inflation cage, should be used if a safe exclusion zone cannot be established;
- Tyre valves should be checked to ensure that they are not leaking. Valve stem caps should always be replaced.

Further detailed guidance on the safe inflation of tyres is given in HSE Publication INDG 433, *Safety during tyre inflation in motor vehicle repair*.

A Real Life Example of Tyre Issues

A 180° excavator operator had been checking the tyre pressures on his machine. Having completed the checks, he was walking away from the machine and one of the front tyres exploded. Subsequent investigation revealed that the tyre, which had recently been replaced, was 10 ply with a 1760 kg, rating rather than the manufacturer's specification of 12 ply with a 2650 kg rating.

The contractor also found that the tyre had been ordered from their approved supplier by asking for a tyre for a Case 580L excavator, without any mention of ply or load rating. A subsequent check of other machines found that 30% were fitted with incorrect tyres.

H.3 Tyre Damage

All tyres should be inspected daily as follows:

- The tread and side walls should be checked for bulges and separation;
- The tread and side walls should be checked for cuts.

When any cut, rip or tear is discovered that exposes sidewall or tread area cords in a pneumatic tyre, steps should be taken to remove the tyre from service immediately. Arrangements must be made for replacement of the tyre or tyre and wheel assembly.

H.4 Tyre Repairs

In the course of a tyre's life, a tyre may be subject to an enormous amount of use and damaged in many ways. Tyres which require repair, OR which appear to require repair, should be removed from the associated wheel and thoroughly inspected because a penetrating object could damage the inside of the carcass, or excessive deflection could cause dislocation of the carcass cords. Plugs inserted from outside the tyre should only be used as a short-term temporary repair until the tyre can be removed from its wheel, the tyre inspected and a permanent repair made.

It is essential that any tyre repairs are carried out by a competent tyre specialist to BS AU 159g: 2013. The repairs should be **permanent**, allowing the tyre to operate at its original speed, load and inflation pressure.

Clause 9 of BS AU 159g:2013, *Specification for repairs to tyres for motor vehicles used on the public highway* specifies that liquid sealant introduced into inner tubes or tubeless tyres to aid air retention properties shall **not** be considered to be a permanent repair.

H.5 Liquid Tyre Sealants

A liquid tyre sealant or gel introduced into inner tubes or tubeless tyres will help improve the air retention properties of a tyre due to punctures or slow leaks. It is, however, essential that the operator carries out a visual inspection of the tyres at the beginning of each working period. Any noticeable defects in a tyre will require the tyre to be removed from the wheel and thoroughly inspected by a competent tyre specialist for any internal damage. Repairs should be carried out to BS AU 159g: 2013 to allow the tyre to operate at its original speed, load and inflation pressure.

NOTE: *Due to the varying nature of the chemical compositions of different tyre sealants, care should be taken when selecting a suitable tyre sealant for the task the machine is being asked to perform.*

H.6 Tyre Replacement

Excavator manufacturers generally list a range of approved tyres in the parts manual for a specific machine. If not using tyres from this list, the replacement tyres must have the following characteristics:

- Same physical size as the original;
- Equal or greater ply and load rating as the original;
- Tyre tread contact width equal or greater than original;
- Equivalent performance specification.

NOTE: *The twin tyres often found on wheeled excavators should be replaced in pairs.*

It is essential that either the excavator manufacturer or a competent tyre specialist is consulted.

Unless specifically approved by the excavator manufacturer, foam filled, or ballast filled tyre assemblies must not be replaced with pneumatic tyres.

When a tyre is being replaced, it is essential that the condition of the other tyres on the machine is assessed by a competent tyre specialist and appropriate action taken. This may include moving part worn tyres around to ensure that the excavator is substantially level when standing on a flat level surface.

If tyres on opposite sides of the excavator are different sizes the boom will not be vertical when the machine is standing on level ground. This will cause the combined centre of gravity of the excavator and load to move sideways, which may lead to instability.

H.7 Wheel Replacement

It is essential that replacement wheels have the same diameter, width and offset dimensions as the originals.

Annex I - Further Information and Guidance

Legislation

Health and Safety at Work etc. Act 1974

Provision and Use of Work Equipment Regulations 1998

L22 *Safe use of work equipment*, HSE Books

The Lifting Operations and Lifting Equipment Regulations 1998

L113 *Safe Use of Lifting Equipment - Lifting Operations and Lifting Equipment Regulations 1998 Approved Code of Practice and Guidance (Second Edition) Published 2014* - ISBN 978 0 7176 6586 0 HSE Books

The Management of Health and Safety at Work Regulations 1999 as amended

The Workplace (Health, Safety and Welfare) Regulations 1992

Work at Height Regulations 2005

The Supply of Machinery (Safety) Regulations 2008

The Construction (Design and Management) Regulations 2015

Personal Protective Equipment at Work Regulations 1992

The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013

Standards

BS EN 474-1:2006, *Earth-moving machinery. Safety - Part 1: General requirements*

BS EN 474-3:2006, *Earth-moving machinery. Safety - Part 3: Requirements for loaders*

BS EN 474-4:2006, *Earth-moving machinery. Safety - Part 4: Requirements for backhoe loaders*

BS EN 474-5:2006, *Earth-moving machinery. Safety - Part 5: Requirements for hydraulic excavators.*

BS 6166-3:1998, *Lifting slings — Part 3: Guide to the selection and safe use of lifting slings for multi-purposes*

BS 6210:1983, *Code of practice for the safe use of wire rope slings for general lifting purposes*

BS 6968:1988, *Guide for use and maintenance of non-calibrated round steel lifting chain and chain slings*

BS 7121-1:2016, *Code of practice for safe use of cranes — Part 1: General*

BS 7121-2-1:2012, *Code of practice for the safe use of cranes - Part 2-1: Inspection, maintenance and thorough examination – General*

BS 7121-2-3:2012, *Code of practice for the safe use of cranes Part 2-3: Inspection, maintenance and thorough examination – Mobile cranes*

BS 7121-3:2017, *Code of practice for safe use of cranes — Part 3: Mobile cranes*

BS 8460:2017, *Safe use of MEWPs – Code of practice*

BS AU 159g:2013, *Specification for repairs to tyres for motor vehicles used on the public highway*

ISO 8643:1997, *Safety of earth-moving machinery. Specification for hydraulic excavator and backhoe loader boom lowering control device*

ISO 10567:2007, *Earth-moving machinery — Hydraulic excavators — Lift capacity*

Other Publications

HSE Leaflet INDG218 – *Guide to Risk Assessment*

HSE Leaflet INDG163 – *Five Steps to Risk Assessment*

HSE Publication L73 - *A guide to the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995*, Fourth edition 2012, HSE Books

HSE Publication GS6 - *Avoidance of Danger from Overhead Electric Power Lines 2013*, HSE Books

HSE Publication HSG 47 - *Avoiding Danger from Underground Services*, Third Edition 2014, HSE Books

HSE Publication HSG 144 - *The safe use of vehicles on construction sites 2009*, HSE Books.

HSE Publication INDG 433, *Safety during tyre inflation in motor vehicle repair*

HSE Research Report RR1078, *The use of vehicle structure in load securing on heavy goods vehicles*

HSE Research Report RR1079, *Access to and work on flatbed vehicles*

HSE Research Report RR1088, *Multi-site delivery issues for heavy goods vehicles*

HSE Safety Notice FOD 1-2015 - *Earth Moving Machinery – changes to visibility requirements*

HSE Sector Information Minute No. 02/2007/02 *Assessing Field of Vision for Operators of Earth Moving Machinery on Construction Sites*

HSE Publication GIS 6, *The selection, management and use of mobile elevating work platforms*

Safe Use of Quick Hitches on Excavators - Best Practice Guide. Strategic Forum for Construction - Plant Safety Group (free download from www.cpa.uk.net)

Safe Use of Telehandlers in Construction - Good Practice Guide. Strategic Forum for Construction - Plant Safety Group (free download from www.cpa.uk.net)

Competence to Operate Construction Plant - Good Practice Guide. Strategic Forum for Construction - Plant Safety Group (free download from www.cpa.uk.net)

Medical Fitness to Operate Construction Plant - Good Practice Guide. Strategic Forum for Construction - Plant Safety Group (free download from www.cpa.uk.net)

Ground Conditions for Construction Plant - Good Practice Guide. Strategic Forum for Construction - Plant Safety Group (free download from www.cpa.uk.net)

Reducing Unintended Movement of Plant - Good Practice Guide. Strategic Forum for Construction - Plant Safety Group (free download from www.cpa.uk.net)

Code of practice for the safe use of lifting equipment. Lifting Equipment Engineers' Association

CECE guidance on the classification of attachments to construction equipment for the machinery directive 2006/42/EC, Committee for European Construction Equipment

BITA Publication GN 67, *Multi-Piece Pneumatic Tyred Wheels - Inspection, Maintenance & Repairs* – British Industrial Truck Association

Useful Websites

Build UK (formally UKCG)	www.builduk.org
Construction Equipment Association	www.thecea.org.uk
Construction Plant-hire Association	www.cpa.uk.net
CITB	www.citb.co.uk
Health and Safety Executive	www.hse.gov.uk
Home Builders Federation	www.hbf.co.uk
Lifting Equipment Engineers Association	www.leea.co.uk
National Plant Operators Registration Scheme	www.npors.com
Safety Assessment Federation	www.safed.co.uk
Strategic Forum for Construction	www.strategicforum.org.uk

Annex J - Working Group Membership

Member	Employer	Representing
P Brown - <i>Chairman</i>	CPA	SFfC Plant Safety Group
B Bolton	Health and Safety Executive	HSE
J Confry	Clancy Group	Construction Plant-hire Association
A Dodman	Barhale	
M Edwards	CITB	CITB
P Flannery	Flannery Plant	Construction Plant-hire Association
C Hassell	Roger Bullivant	Federation of Piling Specialists
S Howard	Lend Lease	Build UK
G Hudson	Lowbury Construction	
H Jones	NPORS Ltd	NPORS Ltd
L Ling	Balfour Beatty	
R Maclean	Land & Water	Construction Plant-hire Association
G O'Neill	John Reilly Civil Engineering Ltd	
K Randall	Balfour Beatty	
P Taylor	Select Plant	Construction Plant-hire Association
T P Watson - <i>Editor</i>	CPA	SFfC Plant Safety Group

NOTE: The above list includes all those who have kindly given freely of their time and expertise to work on the any of the versions of the guidance document and does not necessarily reflect the current membership of the Working Group.

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