

Earth-moving machinery — Safety —

Part 5: Requirements for hydraulic excavators

The European Standard EN 474-5:2006 has the status of a
British Standard

ICS 53.100

National foreword

This British Standard was published by BSI. It is the UK implementation of EN 474-5:2006. It supersedes BS EN 474-5:1996, which will be withdrawn on 1 November 2008.

The UK participation in its preparation was entrusted by Technical Committee B/513, Construction equipment and plant and site safety, to Subcommittee B/513/1, Earth moving machinery (International).

A list of organizations represented on B/513/1 can be obtained on request to its secretary.

The transition period is to allow stock of products manufactured to BS EN 474-5:1996 to be exhausted and for manufacturers to adopt the requirements of the revised standard.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

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Erdbaumaschinen - Sicherheit - Teil 5: Anforderungen für Hydraulikbagger

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Contents

Page

Foreword.....	3
Introduction	4
1 Scope	5
2 Normative references	5
3 Terms and definitions	6
4 List of additional significant hazards	6
5 Safety requirements and/or measures	7
6 Information for use	13
Annex A (informative) List of additional significant hazards – Hydraulic excavators	14
Annex B (informative) Rated lift capacity tables for object handling	16
Annex C (normative) Requirements for excavator swing brakes	20
Annex D (informative) Illustrations	24
Annex ZA (informative) Relationship between this European Standard and the Essential Requirements of EU Directive 98/37/EC	27
Bibliography	28
Figures	
Figure 1 — Tipping lines of walking excavators	12
Figure 2 — Measurement of the tipping load to front/rear	12
Figure 3 — Measurement of tipping load to the side	13
Figure C.1 — Swing service brake	21
Figure D.1 — Crawler excavator.....	24
Figure D.2 — Compact crawler excavator.....	24
Figure D.3 — Wheel excavator	25
Figure D.4 — Compact wheel excavator	25
Figure D.5 — Walking excavator	26
Tables	
Table A.1 — List of additional significant hazards.....	14
Table B.1 — Example of rated lift capacity table for crawler excavators	18
Table B.2 — Example of rated lift capacity table for wheel excavators	19

Foreword

This document (EN 474-5:2006) has been prepared by Technical Committee CEN/TC 151 "Construction equipment and building material machines — Safety", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2007, and conflicting national standards shall be withdrawn at the latest by November 2008.

This European Standard supersedes EN 474-5:1996.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive.

For relationship with EU Directive, see informative Annex ZA, which is an integral part of this document.

For bibliographic references, see EN 474-1:2006.

EN 474 "Earth-moving machinery — Safety" comprises the following parts:

- Part 1: General requirements
- Part 2: Requirements for tractor-dozers
- Part 3: Requirements for loaders
- Part 4: Requirements for backhoe-loaders
- Part 5: Requirements for hydraulic excavators
- Part 6: Requirements for dumpers
- Part 7: Requirements for scrapers
- Part 8: Requirements for graders
- Part 9: Requirements for pipelayers
- Part 10: Requirements for trenchers
- Part 11: Requirements for earth and landfill compactors
- Part 12: Requirements for cable excavators

This European Standard is intended for use in combination with Part 1 of the series.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

This part of EN 474 is a type C standard as stated in EN ISO 12100-1:2003.

The machinery concerned and the extent to which hazards, hazardous situations and events are covered are indicated in the scope of this European Standard.

When provisions of this type C standard are different from those which are stated in type A or B standards, the provisions of this type C standard take precedence over the provisions of the other standards, for machines that have been designed and built according to the provisions of this type C standard.

1 Scope

This part of EN 474 deals with all specific significant hazards, hazardous situations and events relevant to hydraulic excavators as defined in EN ISO 6165:2006, when they are used as intended and under conditions of misuse which are reasonably foreseeable by the manufacturer (see Clause 4).

This part also deals with object handling application, shovel application and log application.

The requirements of this part are complementary to the common requirements formulated in EN 474-1:2006.

This part does not repeat the requirements from EN 474-1:2006, but adds or replaces the requirements for application for hydraulic excavators.

This part specifies the appropriate technical measures to eliminate or reduce risks arising from the significant hazards, hazardous situations and events during commissioning, operation and maintenance of hydraulic excavators.

This European Standard is not applicable to hydraulic excavators manufactured before the date of publication of this European Standard by CEN.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

EN 12643:1997, *Earth-moving machinery — Rubber-tyred machines — Steering requirements (ISO 5010:1992, modified)*

EN 13510:2000, *Earth-moving machinery — Roll-over protective structures — Laboratory tests and performance requirements (ISO 3471:1994, including Amendment 1:1997 modified)*

EN 13531:2001, *Earth-moving machinery — Tip-over protection structure (TOPS) for compact excavators — Laboratory tests and performance requirements (ISO 12117:1997 modified)*

EN ISO 3449:2005, *Earth-moving machinery - Falling-object protective structures - Laboratory tests and performance requirements (ISO 3449:2005)*

EN ISO 2867:2006, *Earth-moving machinery — Access systems (ISO 2867:2006)*

EN ISO 6165:2006, *Earth-moving machinery — Basic types — Vocabulary Identification and terms and definitions (ISO 6165:2006)*

EN ISO 6682:1995, *Earth-moving machinery — Zones of comfort and reach for controls (ISO 6682:1986 including Amendment 1:1989)*

EN ISO 6683:2005, *Earth-moving machinery — Seat belts and seat belt anchorages — Performance requirements and tests (ISO 6683:2005)*

EN ISO 7096:2000, *Earth-moving machinery — Laboratory evaluation of operator seat vibration (ISO 7096:2000)*

EN ISO 12100-1:2003, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology (ISO 12100-1:2003)*

ISO 6014:1986, *Earth-moving machinery — Determination of ground speed*

ISO 7451:1997, *Earth-moving machinery — Volumetric ratings for hydraulic excavator buckets and backhoe loader buckets*

ISO 7546:1983, *Earth-moving machinery — Loader and front loading excavator buckets — Volumetric ratings*

ISO 8643:1997, *Earth-moving machinery — Hydraulic excavator and backhoe loader boom-lowering control device — Requirements and tests*

ISO 10262:1998, *Earth-moving machinery — Hydraulic excavators — Laboratory tests and performance requirements for operator protective guards*

ISO 10567:1992, *Earth-moving machinery — Hydraulic excavators — Lift capacity*

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 474-1:2006, EN ISO 12100-1:2003 and the following apply.

NOTE 1 Terminology for hydraulic excavators are specified in ISO 7135:1993 and illustrated in Annex D (Figures D.1 to D.5) of this European Standard.

NOTE 2 Definitions used in EN and ISO standards referred to in this European Standard are also valid for this document.

3.1 hydraulic excavator
self-propelled machine on crawler, wheels or legs, having an upper structure normally capable of 360° swing with mounted equipment, primarily designed for excavating with bucket, without moving the undercarriage during the work cycle

NOTE 1 An excavator work cycle normally comprises excavating, elevating, swinging and discharging material (see EN ISO 6165:2006).

NOTE 2 Hydraulic excavators may also be used for material handling/transportation.

3.1.1 minimal swing radius excavator (MSRX)
excavator for operation in confined space having an upper structure with a short swing radius (equipment and attachment swing within 120 % of the width of the undercarriage)

3.1.2 compact excavator
excavator and minimal swing radius excavator with an operating mass (see ISO 6016:1998) of less than or equal to 6 000 kg

3.2 walking excavator
excavator with three or more supporting legs which may be articulated, telescopic or both and which can be fitted with wheels

4 List of additional significant hazards

See Annex A.

NOTE Annex A (normative) contains all the significant hazards, hazardous situations and events, as far as they are dealt with in this European Standard, identified by risk assessment as significant for this type of machinery and which require action to eliminate or reduce the risk.

5 Safety requirements and/or measures

5.1 General

Hydraulic excavators shall comply with the requirements of EN 474-1:2006, as far as not modified or replaced by the requirements of this part.

5.2 Access

EN 474-1:2006, 5.2 applies with the exception that dimension G, in EN ISO 2867:2006, Figure 2, can be greater than 600 mm when the hand rails/hand holds are in the door opening.

5.3 Operator's station

5.3.1 Minimum space envelope

On excavators with retractable front window, the cab height above SIP shall not be less than 920 mm measured with the window retracted into the cab.

5.3.2 Operator's protection

5.3.2.1 Operator's protective guard

EN 474-1:2006, 5.3.4 is replaced by the following:

Excavators shall be designed so that an operator's protective guard can be fitted. The manufacturer according to the intended use of the machine shall offer a protective guard. The protective guard shall be in accordance with ISO 10262:1998.

Compact excavators with an operating mass (see ISO 6016:1998) less than or equal to 1 500 kg are excluded from the requirements for a protective guard according to ISO 10262:1998.

5.3.2.2 Roll over and tip over protective structures (ROPS and TOPS)

EN 474-1:2006, 5.3.3 does not apply for hydraulic excavator except for walking excavators, see 5.8.3:

Compact excavators having an operating mass greater than 1 000 kg shall be fitted with a tip over protective structure (TOPS) according to EN 13531:2001.

5.3.2.3 Protection for log application

The excavator shall be equipped with a front protection and, if a relevant hazard exists, with a top protection, according to ISO 10262:1998.

5.3.3 Operator's seat

5.3.3.1 Seat adjustment for compact excavators

EN 474-1:2006, 5.4.1.3, 2nd paragraph only applies to excavators with an operating mass (see ISO 6016:1998) of less than 3 000 kg.

5.3.3.2 Vibration

EN 474-1:2006, 5.4.1.4, applies to excavators except for compact excavators. The seat, except for compact excavators, shall comply with spectral class EM 6 of EN ISO 7096:2000.

NOTE According to EN ISO 7096:2000, 1.2.2, there is no requirement on seat suspension for seats used in excavators.

5.3.3.3 Rear window

EN 474-1:2006, 5.3.2.9 applies with the exception that the rear window of an excavator does not need to be equipped with window wipers, washers and defrosters.

5.4 Controls for driving and steering

EN 474-1:2006, 5.5.1 d) and 5.6.1 apply with the following addition relating to controls for driving and steering:

The movements of the controls for driving and steering do not need to correspond to the intended direction of movement if the upper structure is not in the normal driving direction.

EN 474-1:2006, 5.6.2 applies only to excavators with a travelling speed of higher than 30 km/h measured according to ISO 6014:1986.

For machines with a travel speed equal to or lower than 30 km/h EN 12643:1997 shall be applied, except for the requirements for emergency steering.

5.5 Swing brakes

Swing brakes shall comply with the requirements as defined in Annex C.

5.6 Stability and safety devices

5.6.1 General

EN 474-1:2006, 5.11 applies with the additions given in 5.6.2 to 5.6.4.

All rated capacities as defined hereafter are based on test and/or calculations of machines being level and on firm supporting surface.

The mass of the intended load, its density and the location of its centre of gravity as well as the mass of the attachment and the attachment bracket, if fitted, shall be included in the determination of the rated lift capacity and the size/capacity of the attachment.

To provide a sufficient stability, the rated lift capacity in intended operations shall be determined in accordance with 5.6.2 to 5.6.4

5.6.2 Bucket and shovel application

The rated lift capacity for an excavator used in bucket or shovel application shall be determined either by:

- rated tipping load according to ISO 10567:1992, 3.7, in the most unfavourable position; or
- hydraulic lift capacity according to ISO 10567:1992, 3.9.

whichever is less.

The volumetric rating of the bucket or shovel shall be determined according to ISO 7451:1997 or ISO 7546:1983.

NOTE The mass and the volumetric rating of the bucket and the density of the material have to be taken into account when a bucket is selected for a specific application.

5.6.3 Log application

The rated lift capacity in *stationary* log application shall be determined either by:

- rated tipping load according to ISO 10567:1992, 3.7, with a log in the most unfavourable position; or
- hydraulic lift capacity according to ISO 10567:1992, 3.9.

whichever is less.

The rated lift capacity in moving (driving with load) log application shall be determined either by:

- rated tipping load as 60 % of the tipping load according to ISO 10567:1992, 3.6, with a log in the most unfavourable position; or
- hydraulic lift capacity according to ISO 10567:1992, 3.9.

whichever is less.

5.6.4 Object handling application

5.6.4.1 General

The rated lift capacity of excavators shall be determined according to 5.6.4.2.

5.6.4.2 Rated lift capacity in object handling

The rated lift capacity in object handling shall be determined according to ISO 10567:1992, 3.11.

5.6.4.3 Rated lift capacity table in object handling

A table of the rated lift capacity in object handling, established by the manufacturer, shall be provided. Annex B gives an example for such a table. The table(s) shall be available at the operator's station for each object-handling configuration specified in the operation manual.

5.6.4.4 Load safety devices

Excavators used in object handling operations and with a maximum rated lift capacity according EN 474-1, 3.5 greater than or equal to 1 000 kg, at a minimum lift point radius, as defined in 3.4 of ISO 10567:1992, or an overturning moment greater than or equal to 40 000 Nm, shall be equipped with:

- a) 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 rated lift capacity is defined in 5.6.4.2. This device may be deactivated while the excavator equipment is performing operations other than object handling. The activation shall be clearly indicated. The control of the deactivation shall be within the operator's zone of comfort according to EN ISO 6682:1995. A warning sign shall be placed close to the control device indicating the need for activation during object handling.
- b) a boom-lowering control device on the raising boom cylinder(s) in accordance with ISO 8643:1997.

5.6.4.5 Other applications

The rated lift capacity of derivated machinery shall be determined by the manufacturer according to the load specification given in 5.6.4.2 and 5.6.4.3, whereby the comparable hazard has to be considered for the special application.

5.7 Parking brake for compact crawler excavator

5.7 of EN 474-1:2006 applies with the addition that the working tool (e. g. bucket) or a special attachment (e. g. dozer blade) can alternatively be used to immobilise the machine. The procedure to secure the compact crawler excavator shall be described in the operation manual.

5.8 Specific requirements for walking excavators

5.8.1 Operator's station

5.8.1.1 Steering system

5.6.1 of EN 474-1:2006 does not apply.

5.8.1.2 Visibility

5.8.1 of EN 474-1:2006 does not apply.

The ground contacting part of each leg in all possible positions shall be visible from the operator's station to ensure that the operator can place the legs on firm ground.

5.8.1.3 Egress

In case of failure of source of energy, or with the engine stopped, it shall be possible for the operator to leave the machine safely (e. g. by lowering down the operator's station, steps, stairs).

5.8.2 Wheel brake system

5.7 of EN 474-1:2006 does not apply to walking excavators with not more than two wheels.

5.8.3 Operator's protection

5.8.3.1 Roll-over protective structures (ROPS)

Walking excavators shall be fitted with rollover protective structures (ROPS) that meet the requirements of EN 13510:2000 for backhoe-loaders of equivalent mass.

5.8.3.2 Restraint systems

All walking excavators fitted with a ROPS shall be equipped with an operator restraint system complying with the requirements of EN ISO 6683:2005.

5.8.3.3 Falling-object protective structure (FOPS)

Walking excavators shall be designed so that a falling object protective structure (FOPS) according EN ISO 3449:2005, level II, can be fitted (see also 5.3.4 of EN 474-1:2006).

5.8.3.4 Legs, hydraulic circuit

All leg cylinders shall be fitted with lock valves to prevent the machine from becoming unstable in case of a hydraulic system failure.

5.8.4 Stability

5.8.4.1 General

The stability is determined by the following test conditions:

- a) levelled and firm supporting test surface;
- b) stabilizer and wheels (at max. spread position) extended as specified by the manufacturer;
- c) levelled position of the lower side of the under carriage; approximately 350 mm above the test surface;
- d) tipping lines as shown in Figure 1;
- e) at maximum reach with/without telescopic arm to the front/rear, as shown in Figure 2 and to the side as shown in Figure 3.

5.8.4.2 Bucket application

The rated lift capacity for a walking excavator used in bucket applications shall be determined either by:

— rated tipping load according to ISO 10567:1992, 3.7, in the most unfavourable position;

or

— hydraulic lift capacity according to ISO 10567:1992, 3.9

whichever is less.

The volumetric rating of the bucket shall be determined according to ISO 7451:1997.

NOTE The mass and the volumetric rating of the bucket and the density of the material have to be taken into account when a bucket is selected for a specific application.

5.8.4.3 Object handling application

5.8.4.3.1 General

The rated lift capacity of walking excavators in object handling application shall be determined according to 5.8.4.3.2.

5.8.4.3.2 Rated lift capacity in object handling

The rated lift capacity in object handling shall be determined according to ISO 10567:1992, 3.11.

5.8.4.3.3 Rated lift capacity table in object handling

A table of the rated lift capacity in object handling in relation to the reach and turntable position, established by the manufacturer, shall be provided. Annex B gives an example for such a table. The table(s) shall be available at the operator's station for each object-handling configuration specified in the operation manual.

5.8.4.3.4 Load safety devices

Walking excavators used in object handling operations and with a maximum rated lift capacity according to EN 474-1:2006, 3.5 greater than or equal to 1 000 kg, at a minimum lift point radius, as defined in 3.4 of ISO 10567:1992, or an overturning moment greater than or equal to 40 000 Nm, shall be equipped with:

- a) 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 rated lift capacity is defined in 5.8.4.3.2. This device may be deactivated while the excavator equipment is performing operations other than object handling. The activation shall be clearly indicated. The control of the deactivation shall be within the operator's zone of comfort according to EN ISO 6682:1995. A warning sign shall be placed close to the control device indicating the need for activation during object handling.

- b) a boom-lowering control device on the raising boom cylinder(s) in accordance with ISO 8643:1997.

5.8.5 Retrieval and towing

EN 474-1:2006, 5.15 applies with the exception of 5.15.2 and 5.15.5.

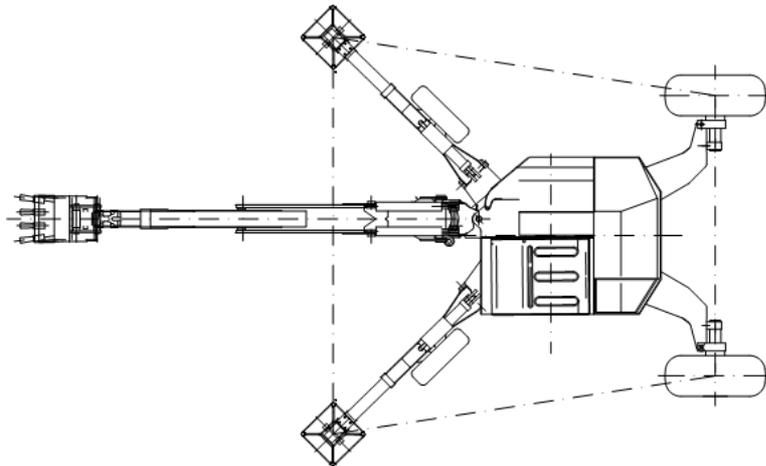
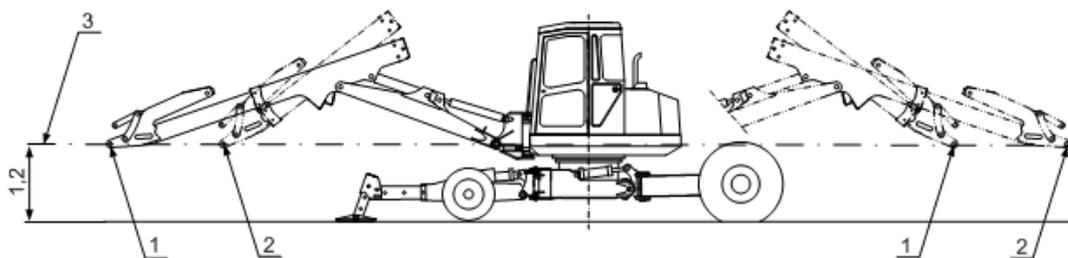


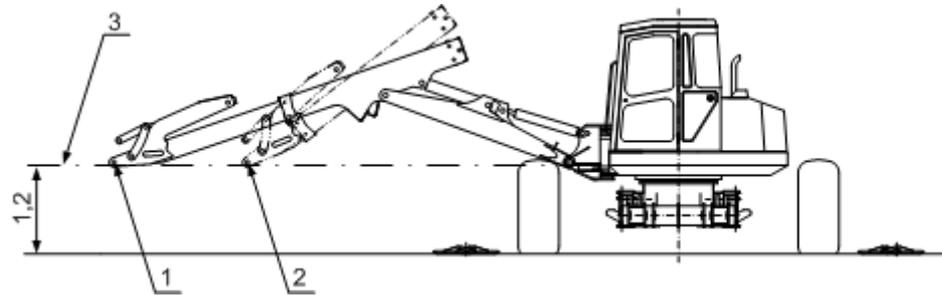
Figure 1 — Tipping lines of walking excavators



Key

- 1 fully extended
- 2 fully retracted
- 3 measuring line (measurements in meter [m])

Figure 2 — Measurement of the tipping load to front/rear



Key

- 1 fully extended
- 2 fully retracted
- 3 measuring line (measurements in meter [m])

Figure 3 — Measurement of tipping load to the side

6 Information for use

EN 474-1:2005, 7.2 applies with the following additions:

- description of the excavator configuration required for object handling;
- parking procedure for compact crawler excavators;
- description of excavator stability in different applications;
- safety instructions for selection and for use of additional protective guards, see 5.3.2 (e. g. demolition work);
- prescription of special precautions for walking excavators;
- instruction shall be given for compact excavators (less than or equal to 1 500 kg) which are not fitted with a protective guard that they shall not be used for applications where the risk of falling objects is given;
- special instructions for log application (reduced travelling speed, avoidance of abrupt brake- or steering-action, central fixing of the trunk, transport-position during movement etc.);
- necessity of a front guard and top guard, in log application;
- instructions for the functioning, the use and the deactivation of the load safety devices of 5.6.4;
- object handling capacity table e.g. in accordance with Annex B.

Annex A (informative)

List of additional significant hazards – Hydraulic excavators

The list of hazards in EN 474-1:2006, Annex A, applies with the following additions:

Table A.1 — List of additional significant hazards

No ¹⁾	Hazard	Relevant clauses of this European Standard
	Hazards, hazardous situations and hazardous events	
1	Mechanical hazards due to: machine parts or working tools, e.g.: -attachment, attachment brackets and/or equipment; -object and log handling	5.6 5.6.3, 5.6.4
1.1	Crushing hazard	5.3.2.1, 5.3.2.2, 5.3.2.3, 5.6.1, 5.6.2, 5.8.3.1, 5.8.3.3
16	Loss of stability/overturning the machine	5.6, 5.6.4, 5.8.3.4, 5.8.4
16.1	Rated operating load with bucket, fork, object handling, log handling and other applications	5.6, 5.8.4
	Additional hazards, hazardous situations and hazardous events due to mobility	
18	Relating to travelling function	
18.4	Travelling function	5.4, 5.8.2
18.6	Insufficient stability of machinery to be slowed down, stopped and immobilised	5.5, 5.7, 5.8.2
19	Linked to the operator's station on the machine	5.3, 5.4, 5.8.1, 5.8.3
19.1	Fall of persons during access to (or at/from) the operator's station	5.2, 5.8.1.3
19.4	Mechanical hazards at the operator's station(s): f) rollover; g) fall of objects, penetration by objects; h) swing brakes; i) protective guard; j) tip over protective structure (TOPS)	5.8.3.1 5.8.3.3 5.5, Annex C 5.3.2.1 5.3.2.2
19.5	Insufficient visibility from the operator's station(s)	5.8.3, 5.8.1.2
19.7	Inadequate seating	5.3.3
19.9	Insufficient means for evacuation/emergency exit	5.8.1.3
20	Due to the control system	
20.3	Inadequate design of manual controls and their mode of operation	5.4

1) Number refers to Annex A of EN 474-1:2006.

No ¹⁾	Hazard	Relevant clauses of this European Standard
22	Due to the power source and to the transmission of power	
22.3	Hazards from retrieval and towing	5.8.5
24	Insufficient instructions for the operator (operation manual, signs, warnings, and markings)	6
25	Mechanical hazards and hazardous events:	
25.1	From load falls, collisions, machine tipping caused by:	
25.1.1	Lack of stability	5.5
25.1.3	Inadequate holding devices/accessories	5.6

Annex B (informative)

Rated lift capacity tables for object handling

B.1 General

This annex provides requirements for the creation of "rated lift capacity tables" for object handling. The table is intended to be available in the cab of hydraulic excavators used in object handling operations.

Tables B.1 and B.2 illustrate examples for crawler and wheel excavators.

B.2 Identification

(See Table B.1 and B.2.)

- a) Table identification;
- b) manufacturer identification and excavator type;
- c) boom identification (length expressed in metres, m);
- d) arm identification (length expressed in metres, m);
- e) counterweight identification (mass expressed in kilograms, kg);
- f) hydraulic pressures, in kilopascals (kPa), as defined in ISO 10567:1992
 - working circuit pressure;
 - holding circuit pressure;
- g) working conditions according to B.4 a) and b);
- h) working conditions according to B.4 c).

B.3 Illustration

- Side-view with the equipment preferably 90° to the longitudinal axis. The excavator and its equipment can be stylised;
- the limit of the equipment working area at the lifting device (without bucket) as defined in ISO 10567:1992 is shown by a wide, solid line;
- the working area is shown on a vertically and horizontally spaced grid with line distances representing 0,5 m, 1 m or 2 m scale;
- the working area can be shown in 1 or be divided into 2 or 3 object handling capacity zones (Z1..., Z3). (See examples in tables B.1 and B.2).

B.4 Working conditions

The working conditions shall be clearly stated e. g.:

- a) If the values given in the rated lift capacity table (distances and load values) have been established with the bucket cylinder installed, the following shall be indicated:

"with retracted bucket cylinder"

- b) If the values given in the rated lift capacity table (distances and load values) have been established without the bucket cylinder, the following shall be indicated:

"without bucket cylinder"

- c) If the values given in the rated lift capacity table (distances and load values) have been established for a complete swing of the upper structure, the following shall be indicated:

"in a complete swing of the upper structure"

- d) The excavator configuration shall be stated by using the following descriptions:

"with the following stabilisation systems":

W On wheels, oscillating axle locked

WB On blade

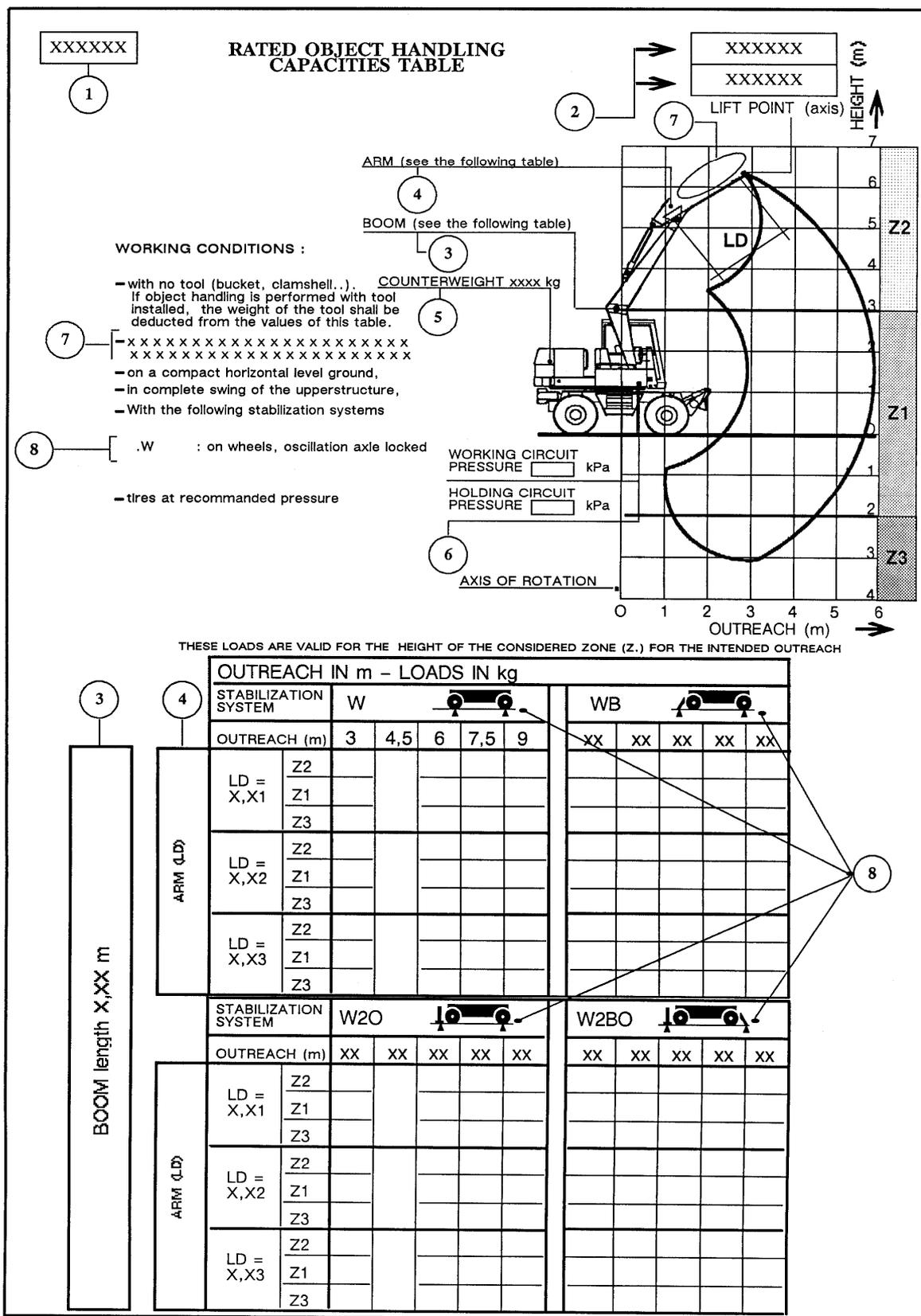
W2O On 2 outriggers

W4O On 4 outriggers

WB2O On 2 outriggers and blade

W...

Table B.2 — Example of rated lift capacity table for wheel excavators



Annex C (normative)

Requirements for excavator swing brakes

C.1 General

This annex specifies minimum performance criteria and methods of test for the swing service brake, swing parking brake and swing lock of excavators as defined in EN ISO 6165:2006.

C.2 Terms and definitions

C.2.1

swing

rotation of the upper structure of an excavator in relation to a fixed reference frame on the ground

C.2.2

working swing revolution speed

turntable-swing speed, reached in a 180° revolution of the upper structure with maximum rotation command input starting from a still position, specified in revolutions per minute

C.2.3

deceleration swing angle

angle measured in degrees of swing while the swing motion is decelerated from working swing revolution speed to a complete stop (halt)

C.2.4

swing torque

torque which propels the upper structure relative to the undercarriage. The swing torque is specified in Nm

C.2.5

swing service brake

device or system to decelerate the rotation of the upper structure and to bring it to a stop in any position

NOTE It can be e. g. a frictional brake, electrically, hydrostatic or other hydraulically operating brake.

C.2.6

swing parking brake

device or system to hold the stopped upperstructure in a stationary position

C.2.7

swing lock

mechanically engaged device to block the upperstructure in a fixed position with respect to the undercarriage

C.3 Minimum performance

C.3.1 Swing movement

C.3.1.1 Test-swing revolution speed

The test-swing revolution speed shall be the working swing revolution speed as defined in C.2.2.

C.3.1.2 Deceleration swing angle β_B

The deceleration swing angle β_B shall be less than the highest of the following values:

$$\beta_B = 90^\circ$$

$$\beta_B = \frac{n^2 \times 360}{2 \times n'_B} + \beta_{B0}$$

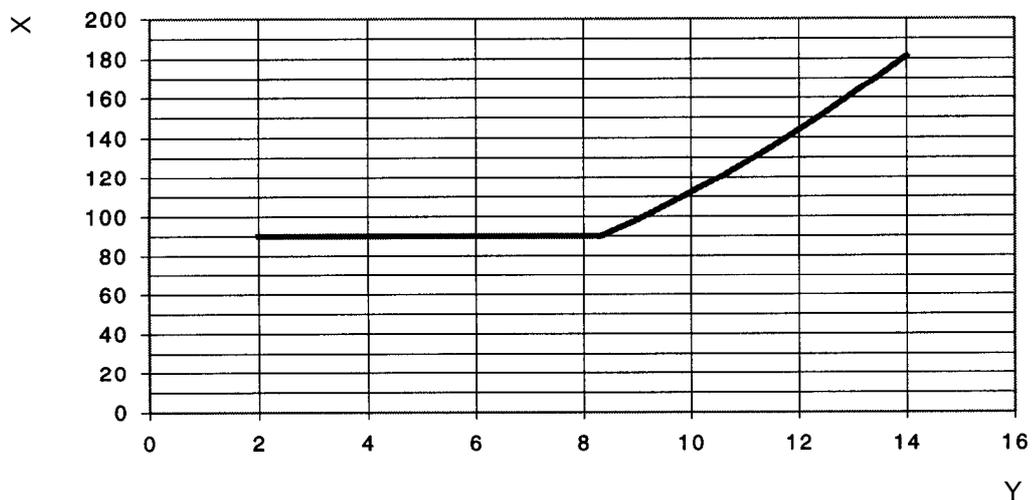
with

$\beta_B =$ is the deceleration swing angle expressed in degrees [°];

$n = n$ is the test-swing revolution speed expressed in revolutions per minutes [min^{-1}];

$n'_B =$ is 250 [min^{-2}];

$\beta_{B0} =$ is 40 degrees [°].



Key

X deceleration swing angle [°]

Y upperstructure-revolution [min^{-1}]

Figure C.1 — Swing service brake

C.3.2 Swing service brake

The swing service brake shall be capable to decelerate the upper structure to a complete stop from the test swing revolution speed as specified in C.3.1.1. It shall not be possible to render non-operational the service brake.

During 10 tests the deceleration swing angle shall not be higher than 120 % of the deceleration swing angle β as defined in C.3.1.2. These ten (10) actuations shall be in a sequence rate as rapidly as the swing acceleration and deceleration will allow.

C.3.3 Swing parking brake

The swing parking brake shall be capable of holding the upper structure for 30 min in the maximum slope and in the most unfavourable position of the upper structure, as specified by the manufacturer. The working equipment shall be extended to maximum radii with the empty bucket in rollout position.

The swing parking brake shall apply automatically in case of engine stop or shall be capable of being manually applied, with and without the engine running.

The swing parking brake shall remain effective when the source of energy fails.

The swing parking brake on excavators with an operating mass greater than or equal to 6 000 kg shall be fully mechanical, e. g. spring friction brake. On excavators with an operating mass less than 6 000 kg the swing parking brake may be a hydraulic lock valve applied directly to the swing motor and if so a separate swing lock according C.3.4 shall be provided.

NOTE 1 The above requirement to have the swing parking brake fully mechanical does not prevent future development toward other types of technology providing equivalent safety.

NOTE 2 Swing parking brake could perform as emergency brake in case of failure of hoses.

Excavators with an operating mass less than 1 000 kg do not require a swing parking brake.

C.3.4 Swing lock

The swing lock shall be capable of withstanding without permanent deformation the maximum swing motor torque.

A swing lock is not required if its function, as defined in C.2.7, is provided by the swing parking brake.

C.4 Test conditions

The tests shall be made with the standard equipment as specified by the manufacturer.

Outriggers and blade, if present, shall be placed on the ground in their working position as specified by the manufacturer.

All fluid system shall be filled as specified by the manufacturer. The fuel tank shall be at least half full. The swing system pressures shall be adjusted and function as specified by the manufacturer.

The test for the swing service brake to define the test swing revolution according to C.3.1.1 and deceleration swing angle according to C.3.1.2 shall be made with the working equipment extended to maximum radii with the empty bucket in rollout position.

The measurement starts with the actuation of the braking at test swing revolution speed.

For the test of the service swing brake and the swing lock the machine shall be positioned on a flat surface with a maximum gradient slope of $\pm 1\%$.

C.5 Test report

The test report shall contain the following information:

- machine manufacturer;
- model and serial-number;
- machine specification;
- result of test.

Annex D
(informative)

Illustrations

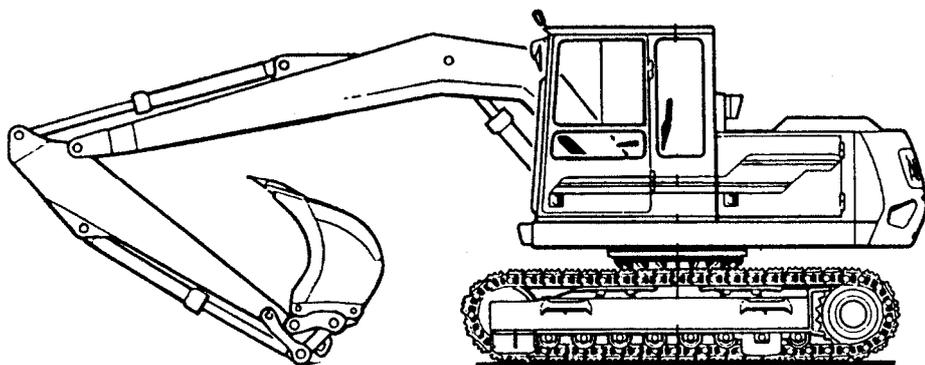


Figure D.1 — Crawler excavator

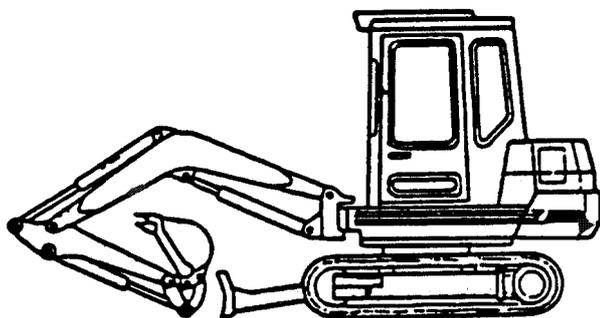


Figure D.2 — Compact crawler excavator

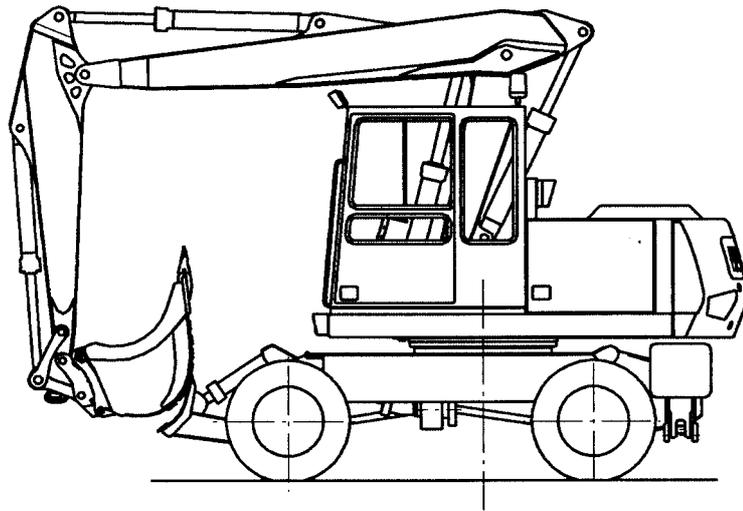


Figure D.3 — Wheel excavator

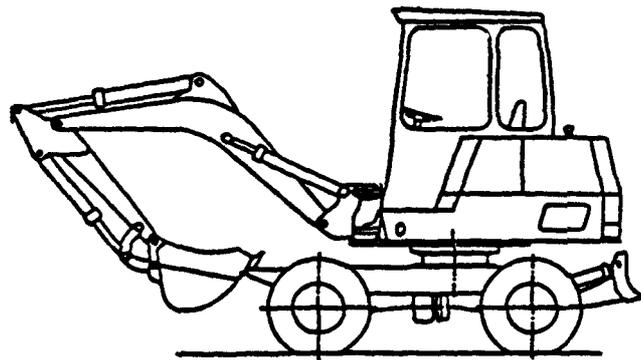


Figure D.4 — Compact wheel excavator

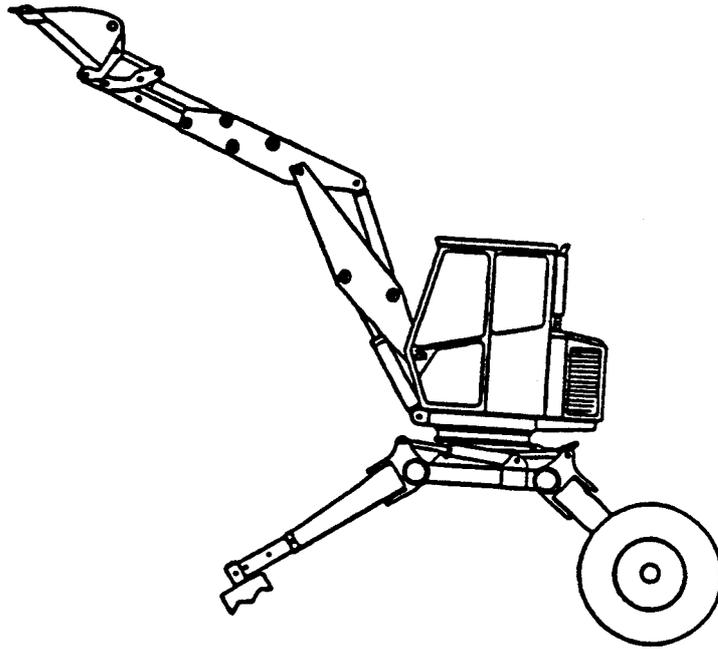


Figure D.5 — Walking excavator

Annex ZA (informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 98/37/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive Machinery 98/37/EC, amended by 98/79/EC.

Once this standard is cited in the Official Journal of the European Communities under that Directive and has been implemented as a national standard in at least one Member State, compliance with the normative clauses of this standard confers, within the limits of the scope of this standard, a presumption of conformity with the relevant Essential Requirements of that Directive and associated EFTA regulations.

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

Bibliography

- [1] ISO 6016:1998, *Earth-moving machinery — Methods of measuring the masses of whole machines, their equipment and components*
- [2] ISO 7135:1993, *Earth-moving machinery — Hydraulic excavators — Terminology and commercial specifications*

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