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Earth-moving machinery — Hydraulic excavator and backhoe loader lowering control device — Requirements and tests

Engins de terrassement — Dispositif de contrôle d'abaissement de la flèche des pelles et chargeuses-pelleteuses hydrauliques — Exigences et méthodes d'essai

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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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Foreword

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This document was prepared by Technical Committee ISO/TC 127, *Earth-moving machinery*, Subcommittee SC 1, *Test methods relating to safety and machine performance*.

This third edition cancels and replaces the second edition (ISO 8643:1997), which has been technically revised and contains the following changes:

— requirements and test provisions have been extended to support a wider range of lowering control device configurations.

Introduction

Where excavators or backhoe loaders are used for object handling, a failure or rupture in the hydraulic circuit can endanger persons under raised loads.

This risk can be reduced by applying a lowering control device, which ensures controlled lowering of the load in the case of a hydraulic line failure or rupture.

Test procedures are based on the design characteristics of the hydraulic systems of hydraulic excavators and the backhoe part of backhoe loaders, and conditions of use.

Earth-moving machinery — Hydraulic excavator and backhoe loader lowering control device — Requirements and tests

1 Scope

This document establishes uniform requirements and test procedures for lowering control devices fitted on the boom, intermediate boom and arm cylinders of hydraulic excavators and backhoe loaders to control the rate of drop in the case of a hydraulic line failure or rupture.

It is applicable to the lowering control devices of hydraulic excavators and the backhoe equipment of backhoe loaders used for object handling which are equipped with the standard linkage as defined by the manufacturer. On machines where alternative linkage combinations are offered, only the standard length defined by the manufacturer is subject to testing.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 6165, *Earth-moving machinery — Basic types — Identification and terms and definitions*

ISO 9248:1992, *Earth-moving machinery — Units for dimensions, performance and capacities, and their measurement accuracies*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6165 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
linkage control system
hydraulic control components (including pilot and slave valves) used for raising and lowering the lift point in object handling applications

3.2
lifting linkage
assembly of parts that can be a combination of booms and arms used for raising and lowering the lift point in the object handling process

3.3
lowering control device
hydraulic control valves used for controlled linkage lowering in the case of a hydraulic line failure or rupture

3.4
failure-simulation device
hydraulic valves used for simulating a failure or rupture in a hydraulic line in the linkage control system

3.5
signal line
hydraulic circuit that is used to sense a pressure

EXAMPLE Diagnostic test port, stability limit system.

3.6
rated lift capacity
smaller of either the rated tipping capacity or the rated hydraulic lift capacity

[SOURCE: ISO 10567:2007, 3.13]

3.7
lift point
LP
location on the attachment (e.g. bucket) or the quick coupler, as specified by the manufacturer, to which a load can be attached

[SOURCE: ISO 10567:2007, 3.2, modified]

3.8
lift point radius
LPR
horizontal distance from the axis of rotation to the vertical hoist line or tackle

[SOURCE: ISO 10567:2007, 3.5]

3.9
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 stabilizing (whilst transporting) the load

Note 1 to entry: If the load is picked-up by a self-acting device and no assistance of a person is required for hooking, unhooking or stabilizing the load, this work is considered as a usual earth-moving application.

Note 2 to entry: Lifting accessories are, e.g. wire ropes, chains or textile straps; loads in object handling application are, e.g. pipes, vessels; self-acting devices are, e.g. grabs, clamshell buckets, log clamps, vacuum lifting device, magnetic plate or fork.

4 Lowering control device requirements

4.1 Lowering control devices shall comply with the requirements given in 4.1.1 to 4.1.8.

4.1.1 The lowering control device shall operate automatically while the cylinders in the linkage control system that keep the load in a lifted position are pressurized, even if the machine/ignition is switched off.

4.1.2 The operation of the lowering control device shall not detract from the normal response of the machine during use and shall not at any time endanger the stability of the machine.

4.1.3 A relief valve to protect the cylinder may be fitted between the cylinder and the lowering control device.

4.1.4 In the case of a failure in the linkage control system, lowering the load shall be possible without endangering persons or the stability of the machine.

4.1.5 Each cylinder in the linkage control system that keeps the load in a lifted position shall have the following secured to it:

a) the lowering control device as well as related tubes and fittings between the lowering control device and the cylinder (hoses are not acceptable);

b) when provided, a separate relief valve (see 4.1.3) as well as related tubes and fittings to connect it in parallel with the lowering control device.

Tubes and fittings related to connecting the control valve, and the relief valve when provided in parallel to the cylinder, shall have a minimum burst pressure of four times the working circuit pressure for that part of the system.

4.1.6 If signal lines are present, then rupture of one of these lines shall result in an oil leakage of not more than 10 L/min for each cylinder at an oil temperature of approximately 40 °C to 50 °C at the specified working circuit pressure.

4.1.7 If equalizing lines between cylinders are present, then rupture of one of these lines shall result:

— for machines with an operating mass (according to ISO 6016) of up to 40 t — in an oil leakage lower than 10 L/min for each cylinder at an oil temperature of 40 °C to 50 °C at the specified working circuit pressure;

— for machines with an operating mass (according to ISO 6016) equal to or greater than 40 t — in a cylinder stroke speed lower than 3 % per second of the total stroke for each cylinder at an oil temperature of 40 °C to 50 °C at the specified working circuit pressure.

NOTE Further investigation concerning the application of the requirement to arm cylinder equalizing line is needed; in the meantime, the requirement can be applied to the arm cylinder as well.

4.1.8 Performance requirements

Lowering control devices (and equalizing or signal lines, if present) shall be tested in accordance with the test conditions and acceptance criteria given in Table 1.

Table 1 — Performance requirements

Test condition	Test load setup height	Machine and control setup	Acceptance criteria	Ref.
Testing of internal leakage	1,0 m ± 0,1 m above ground	All controls in neutral	Vertical drop rate ≤ 10 mm/s	5.3.2
Holding position	1,0 m ± 0,1 m above ground	All controls in neutral Failure-simulation device opened	Total vertical drop in 10 s ≤ 100 mm	5.3.3
Raising	1,0 m ± 0,1 m above ground	Raise smoothly and continuously Failure-simulation device opened Keep lowering control device in position	Total vertical drop in 10 s ≤ 100 mm	5.3.4
Lowering	1,0 m ± 0,1 m above ground or higher minimum height so that the test load does not come into contact with the ground surface during the test	Lower smoothly and continuously Failure-simulation device opened All controls in neutral	— The increase in the lowering speed of the test load shall be less than 100 % increase of the initial speed averaged over a period of at least 2 s — Total vertical drop in 10 s ≤ 100 mm	5.3.5
Equalizing/ Signal lines	No load	Linkage at maximum lift height	— ≤ 40 t: oil leakage < 10 L/ min — > 40 t: a cylinder stroke speed of not more than 3 % per second of the total stroke for each cylinder	5.3.6

5 Test method

5.1 Apparatus

5.1.1 Means of measuring displacement in the vertical plane against time, to an accuracy according to ISO 9248:1992.

Scales and stopwatches are allowed provided they meet the requirement on accuracy indicated in 5.1.1.

5.1.2 Thermometer, or equivalent temperature measuring device, measuring from 0 °C to 100 °C with an accuracy of ±1 °C.

5.1.3 Collecting container, for hydraulic oil, or alternatively, an oil return line to the tank.

5.2 Preparation for test

5.2.1 Test and recording methods ensuring repeatable and reproducible results shall be used (e.g. video recording against a fixed background scale).

5.2.2 A failure-simulation device shall be installed in any hydraulic line in the linkage control system, failure of which could cause the lifting linkage to lower if the lowering control device was not installed.

Examples of such installations are as follows:

a) in the line between the cylinder and control valve, as shown in Figure 1;

b) in the signal line between the cylinder and machine side monitoring testing devices (for example, pressure sensor), as shown in Figure 2;

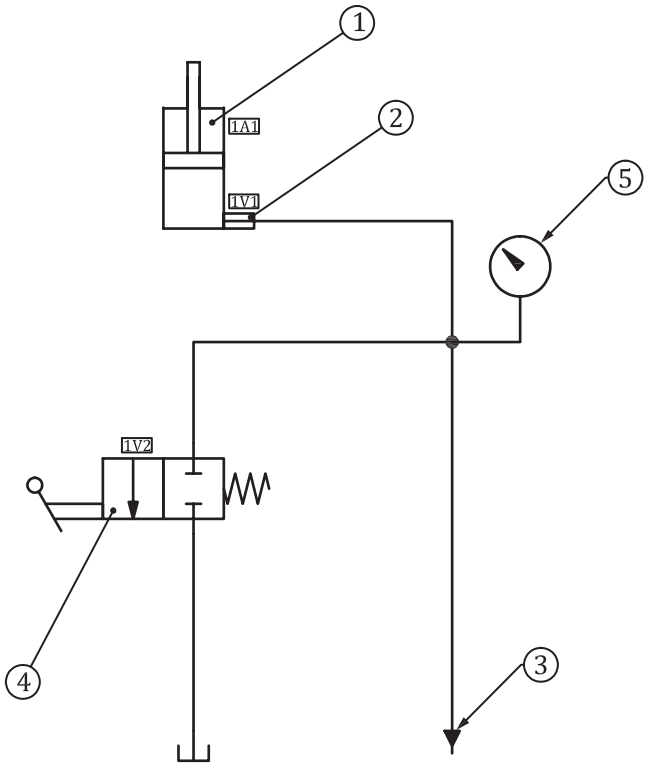
c) in the equalizing line between the cylinders, as shown in Figure 3.

This can require running multiple tests with the failure-simulation device in different locations. For example:

— a test with the failure-simulation device in the line between the cylinder and the control valve [see a) above] and

— a test with the failure-simulation device in the equalizing line between cylinders [see c) above].

The failure-simulation device shall be of a size that when the device is fully open, the pressure drop over the device in the tests described in 5.3 is less than 10 bar[1)].



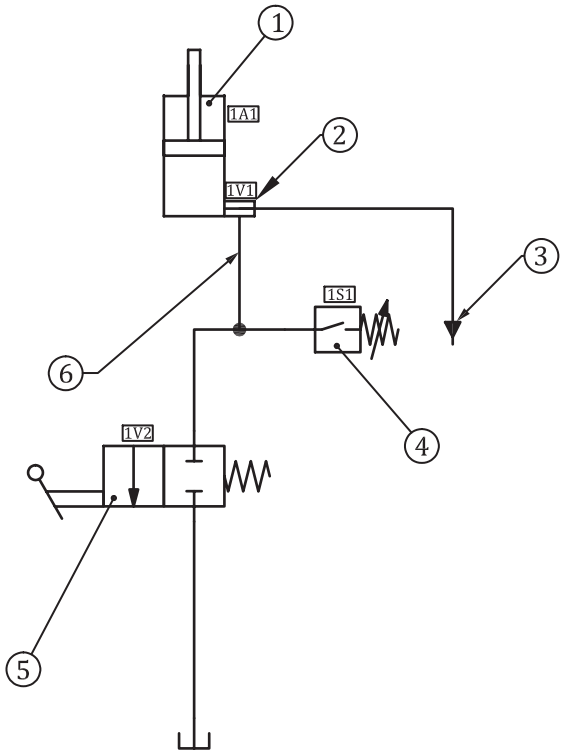
Key

1 cylinder
2 lowering control device
3 directional control valve
4 failure-simulation device
5 pressure sensor

NOTE Diagrams, symbols and labels are in accordance with ISO 1219-1 and ISO 1219-2.

Figure 1

1) 1 bar = 0,1 MPa = 0,1 N/mm^2 = 105 N/m^2.

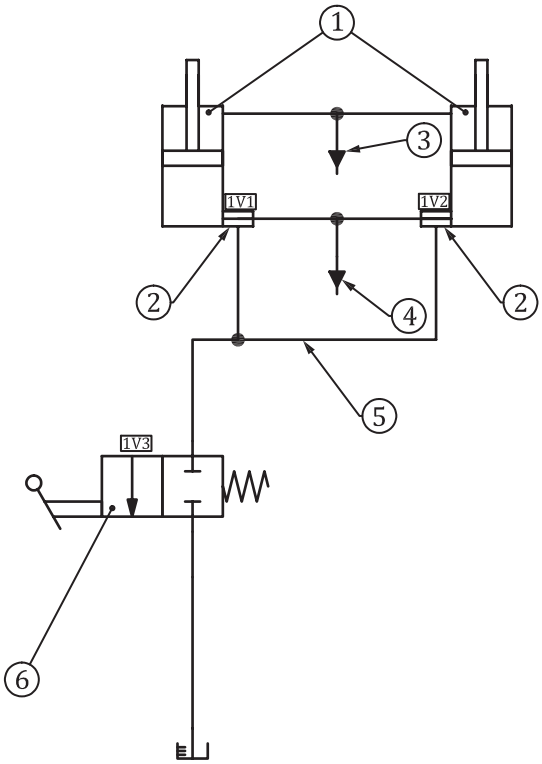


Key

1 cylinder
2 lowering control device
3 directional control valve
4 machine side monitoring devices (e.g. pressure sensor)
5 failure-simulation device
6 signal line

NOTE Diagrams, symbols and labels are in accordance with ISO 1219-1 and ISO 1219-2.

Figure 2



Key

1 cylinders
2 lowering control device
3 directional control valve
4 directional control valve
5 equalizing line
6 failure-simulation device

NOTE Diagrams, symbols and labels are in accordance with ISO 1219-1 and ISO 1219-2.

Figure 3

5.2.3 The complete hydraulic system shall be operated until the temperature of the hydraulic oil in the oil reservoir is 40 °C to 50 °C. The hydraulic fluid shall be of the type and grade specified by the manufacturer.

5.3 Testing of lowering control device

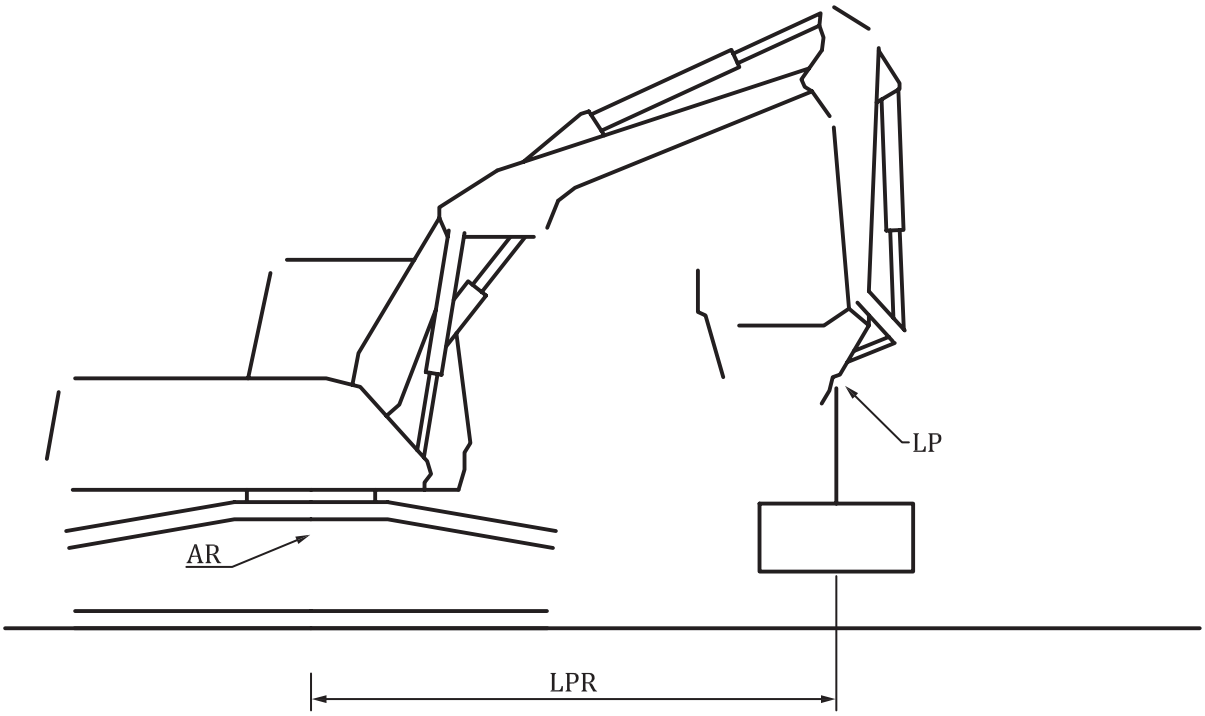
5.3.1 General

The tests specified in 5.3.2 to 5.3.5 shall be conducted separately and recorded for each lowering control device provided.

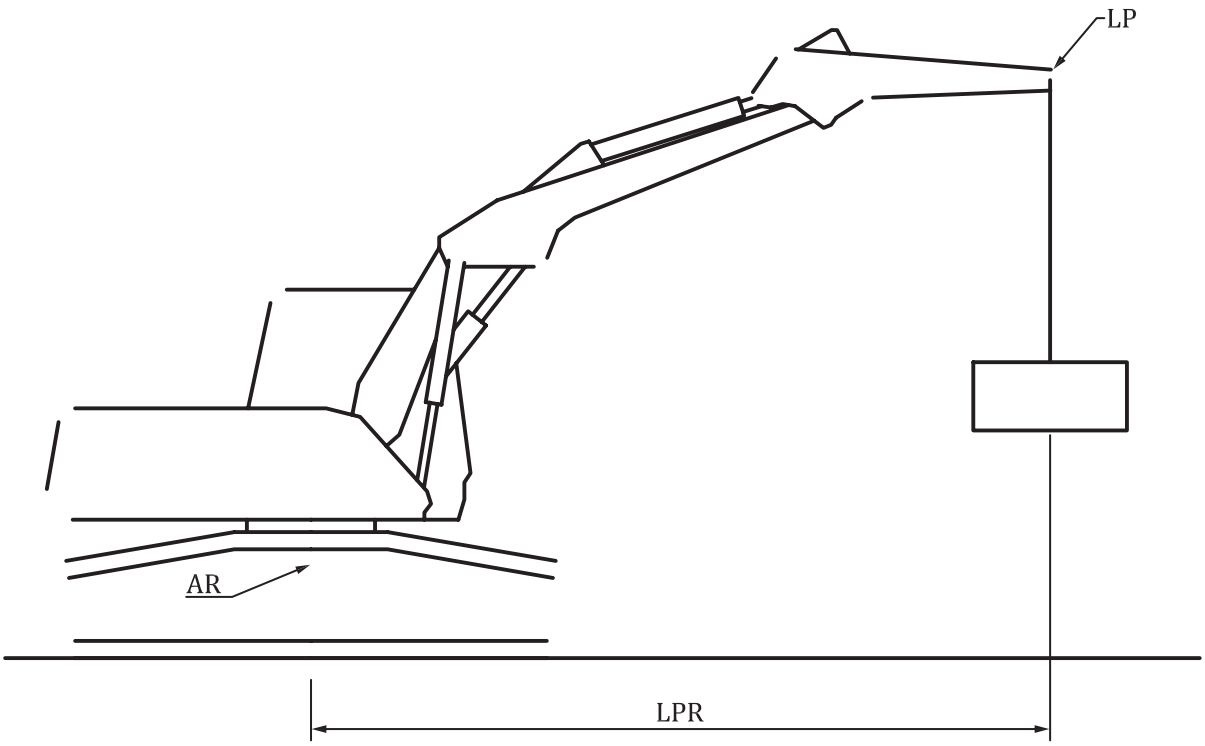
When the test requires raising or lowering of any part of the lifting linkage, this movement shall be smooth and at a test load speed of 150 mm/s ± 50 mm/s.

The load shall be lowered and set down after each test.

The machine lifting linkage should be in a typical lifting position, as shown in Figure 4 a) and Figure 4 b) for boom testing, and with the arm approximately horizontal for arm testing as shown in Figure 4 b) at the start of each test. A test load equivalent to 55 % ± 5 % of the rated lift capacity at that lifting linkage position shall be applied at the lift point radius.



a) Machine in a typical lifting position for boom testing



b) Machine in typical lifting position for boom or arm testing

Key

AR axis of rotation
LPR lift point radius
LP lift point

Figure 4

5.3.2 Testing of internal leakage

The lowering control device shall be in the neutral position.

The vertical drop rate of the load due to internal leakage in the system shall not exceed 10 mm/s.

5.3.3 Testing of holding position

The test load shall be positioned at a height so that the test load does not come into contact with the ground surface during the test.

With the lowering control device in the neutral position, the failure-simulation device shall be opened.

The total vertical drop of the load during the initial 10 s shall be measured. The total drop shall not exceed 100 mm.

5.3.4 Testing during raising

The test load shall be positioned at a height so the test load does not come into contact with the ground surface during the test.

The test load shall be lifted smoothly and continuously without shock (see 5.3.1).

The failure-simulation device shall be opened during raising without changing the position of the lowering control device.

The total drop of the load during the initial 10 s shall be measured; the total drop shall not exceed 100 mm.

5.3.5 Testing during lowering

The test load shall be positioned at a height so the test load does not come into contact with the ground surface during the test.

The test load shall be lowered smoothly and continuously without shock (see 5.3.1).

The failure-simulation device shall be opened. The following may be measured simultaneously or separately. If done separately, the initial lowering speed for both measurements shall be as specified in 5.3.1.

a) Without changing the position of the lowering control device, measure the increase in the lowering speed. The increase in the lowering speed of the test load shall be less than 100 % increase of the initial speed averaged over a period of at least 2 s.

b) Measure the total drop of the load after the lowering control device is moved to the neutral position. The lowering control device shall be able to limit load movement so that the total drop of the load during the initial 10 s after moving the lowering control device to neutral shall not exceed 100 mm.

5.3.6 Testing of equalizing lines or signal lines

5.3.6.1 Testing shall be performed without load.

5.3.6.2 The linkage shall be raised to the position in Figure 4, and the lowering control device moved to the neutral position.

5.3.6.3 The failure-simulation device shall be opened.

5.3.6.4 If a cylinder equalizing line or signal line is present, this line shall be designed to comply with the acceptance criteria given in 4.1.7 for equalizing/signal lines or the cylinder equalizing line or signal

line shall be protected with a lowering control device. All lowering control devices installed on cylinder equalizing lines or signal lines shall be tested in accordance with this document.

Bibliography

[1] ISO 1219-1:2012, *Fluid power systems and components — Graphical symbols and circuit diagrams — Part 1: Graphical symbols for conventional use and data-processing applications*

[2] ISO 1219-2:2012, *Fluid power systems and components — Graphical symbols and circuit diagrams — Part 2: Circuit diagrams*

[3] ISO 6016:2008, *Earth-moving machinery — Methods of measuring the masses of whole machines, their equipment and components*

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

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