
**Earth-moving machinery — Safety
requirements for remote operator control
systems**

*Engins de terrassement — Exigences de sécurité relatives aux
systèmes de commande à distance utilisés par l'opérateur*

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15817 was prepared by Technical Committee ISO/TC 127, *Earth-moving machinery*, Subcommittee SC 2, *Safety, ergonomics and general requirements*.

This second edition cancels and replaces the first edition (ISO 15817:2005), which has been technically revised.

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Earth-moving machinery — Safety requirements for remote operator control systems

IMPORTANT — The electronic file of this document contains colours which are considered to be useful for the correct understanding of the document. Users should therefore consider printing this document using a colour printer.

1 Scope

This International Standard specifies the essential safety requirements for remote operator control systems used on earth-moving machinery as defined in ISO 6165. It is not applicable to autonomous control systems that enable a machine to work without the assistance of an operator, nor does it apply to the remote control of attachments on non-remote controlled machines.

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.

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

ISO 6405-1, *Earth-moving machinery — Symbols for operator controls and other displays — Part 1: Common symbols*

ISO 6405-2, *Earth-moving machinery — Symbols for operator controls and other displays — Part 2: Specific symbols for machines, equipment and accessories*

ISO 9244, *Earth-moving machinery — Machine safety labels — General principles*

ISO 13766, *Earth-moving machinery — Electromagnetic compatibility*

ISO 13850, *Safety of machinery — Emergency stop — Principles for design*

ISO 15998, *Earth-moving machinery — Machine-control systems (MCS) using electronic components — Performance criteria and tests for functional safety*

IEC 60068-2-31, *Environmental testing — Part 2-31: Tests — Test Ec: Rough handling shocks, primarily for equipment-type specimens*

IEC 60529, *Degrees of protection provided by enclosures (IP code)*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 control cable
electric wire for transmitting signals between the remote control box and the receiving unit for a wired remote control system

3.2 direct control
control of the machine by an operator in physical contact with the machine

3.3 emergency stop device
manually actuated device, located on the machine, used to initiate an emergency stop function

3.4 emergency stop function
function that is intended to

- avoid impending, or reduce existing, hazards to persons, damage to machinery or to work in progress, and
- be initiated by a single human action

NOTE 1 Hazards, for the purposes of this International Standard, are those which can arise from

- functional irregularities (e.g. machinery malfunction, unacceptable properties of the material processed, human error),
- normal operation.

NOTE 2 Adapted from ISO 13850:2006, definition 3.1.

3.5 hazard zone
area defined by the intended use of the machine where potential for injury might exist due to movement of the machine and its application

3.6 receiving unit
device located on the machine to receive signals emitted from the remote control box and to process these signals into machine operating orders

NOTE It consists of the following elements:

- receiving element that receives signals from the remote control box;
- monitoring element for confirming signals;
- output intersection element that drives the control devices of the machine.

The receiving unit may also include means of return signal transmission for confirmation.

3.7 remote control
remote operator control
operator control of a machine by wireless or wired transmission of signals from a remote control box not located on the machine to a receiving unit located on the machine

3.8**remote control box**

device, not on the machine, that transmits signals to actuate all needed operating functions for control of the machine

NOTE The signals are transmitted from the remote control box to the receiving unit.

3.9**remote control system**

system consisting of a remote control box and receiving unit that transmits operational control information to and from a remote controlled machine

3.10**remote controlled operation**

operation of a machine by an operator distant from the machine

3.11**remote stop**

device on the remote control unit and/or “portable” (e.g. hand-held) device that causes all controlled machine hazardous movement to stop

4 Requirements for remote operator control**4.1 General requirements****4.1.1 Design**

The principles of ISO 15998 should be followed in the design of remote control, safety-related, machine control systems using electronic components.

Remote control systems shall be designed so that all powered movement is prevented for any of the following conditions:

- a) the operator controls are not activated;
- b) loss of the power supply of the remote control system;
- c) loss of the signal between the remote control box and the receiving unit;
- d) loss of the machine power supply that interrupts any part of the remote control system;
- e) any remote control operation interlock not in place and/or functional.

Re-establishing the power supply or the signal between the remote control box and the receiving unit shall not create unintended hazardous machine motion. Resuming remote controlled operation shall only be possible after an intentional reset of machine operation by the operator.

When hazardous zones of the machine are not visible to the remote control operator, there shall be means for the operator to provide a warning before the engine or machinery is started. Exposed personnel shall be given time to leave the hazardous zone or have the means to prevent the engine or machinery from starting.

4.1.2 Wireless control

Remote control systems shall have a means (indicator light, beacon, audible alarm, etc.) of identifying the corresponding controlled machine prior to the start of the remote operation. The warning device specified in 4.10 may be used.

4.1.3 Wired control

The control cable shall be of sufficient length and flexibility to allow the operator to maintain an operating position outside the hazard zone. Excessive tension on the control cable shall not cause actuation of the controls. Any failure of the control cable or connection shall cause powered machine movement to stop.

4.2 Signal integrity

The signal transmission system shall have an error detection and/or correction system to prevent the machine controls from being actuated by false signals resulting from burst levels of electromagnetic radiation, temporary signal loss, etc. The data communication protocol shall continually verify the integrity of the communication link and of the data being transmitted. If signal integrity cannot be verified, remote controlled powered movement shall stop until signal integrity has been re-established and the operator has performed an intentional reset.

4.3 Operating range (wireless)

The operating range of the remote control shall be sufficient to allow the operator to be outside the hazard zone; this range shall be clearly stated in the operator's manual.

4.4 Remote control box

4.4.1 Design

Machine movement, other than machine stop, shall only be able to be controlled from one remote control box at a time.

By design and the application of ergonomic principles, the remote control box should minimize restriction of the machine operator's freedom of movement.

The presence of electrical power at the remote control box shall be indicated by an optical device, e.g. LED or panel light.

4.4.2 Operator controls

4.4.2.1 General

Continuously running work function controls (e.g. attachment controls) and float controls may be held in a detent position. Other machine operational controls on the remote control box shall return to their neutral position when the operator releases the control or shall require an alternative sustained operator input control (e.g. hold-to-run).

When the controls are in their neutral or detent position, the resulting machine action shall be the same as when the corresponding controls on the machine, if present, are in their neutral or detent position. Instructions shall be provided in the operator's manual for the approved use of continuously running work function controls and float controls.

4.4.2.2 Marking

The controls on the remote control box shall be clearly marked with the directional orientation and direction of movement for the machine and its equipment/attachment, in accordance with ISO 6405-1 and ISO 6405-2. The markings shall be consistent with the control markings on the machine, if the machine is so equipped.

4.4.2.3 Protection against unintended actuation

The controls on the remote control box shall be so arranged, deactivated or guarded as to protect against unintended actuation. A means shall be provided to guard against actuation where the remote control box might fall from the operator's hands or the operator fall while operating the remote control box.

4.4.2.4 Protection against unauthorized actuation

A means to protect against unauthorized actuation shall be provided on the remote control box.

EXAMPLE Key switch or access code.

Operation of the remote control shall not be possible unless this means is enabled.

4.4.2.5 Machine holding function

A means to keep the machine stationary shall be provided on the remote control box.

EXAMPLE Activation of a parking brake or other method as specified in the operator's manual.

4.4.2.6 Fire suppression system

For remote controlled machines equipped with a fire suppression system, activation shall be automatic or a means to activate remotely shall be provided.

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4.5 Machine stop

4.5.1 General

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A machine stop control shall be present on the remote control box and on the machine. It shall not be possible to restore the operation of a machine until all stop devices previously operated or activated have been reset. Stop controls shall apply fail-safe design.

4.5.2 Remote stop

A remote stop device shall be present on the remote control box. Control shall generally be obtained by a push-button device or an alternative device which is easily activated. Either the device or its marking shall be red in colour.

Additional remote stop devices, e.g. "portable" hand-held units, that can only control the stop function may also be used, provided they meet the same requirements defined above for a remote stop device on the remote control box.

4.5.3 Emergency stop

Where risk assessment gives clear evidence that the operation of an emergency stop device, located on the machine, is possible without additional risk, at least one emergency stop device conforming with the principles of ISO 13850 shall be present on the machine operable by a person standing at ground level.

4.6 Control selection

4.6.1 Direct control

If the machine can also be direct controlled, a control selecting switch meeting the requirements of 4.6.2 to 4.6.6 shall be provided.