
**Tractors and self-propelled machinery for
agriculture — Operator controls —
Actuating forces, displacement, location
and method of operation**

*Tracteurs et machines agricoles automotrices — Commandes de
l'opérateur — Forces de manœuvre, déplacements, emplacements et
modes de fonctionnement*



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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 15077 was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 3, *Safety and comfort*.

This first edition of ISO 15077 cancels and replaces ISO/TS 15077:2002, of which it constitutes a technical revision.

Introduction

This International Standard has been developed to provide preferred methods of operation and requirements for operator controls. These provisions were derived from experience, current practice, human factors literature and existing standards. Specific operating requirements are given for controls common to many agricultural machines.

Tractors and self-propelled machinery for agriculture — Operator controls — Actuating forces, displacement, location and method of operation

1 Scope

This International Standard specifies the preferred method of operation and requirements related to operator controls actuated by hand and foot, installed in agricultural tractors and self-propelled agricultural machinery and used by a seated operator as intended and under the conditions foreseen by the manufacturer. It also gives recommendations for the maximum control actuating forces, direction of motion and location of these controls.

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 3767-1, *Tractors, machinery for agriculture and forestry, powered lawn and garden equipment — Symbols for operator controls and other displays — Part 1: Common symbols*

ISO 3767-2, *Tractors, machinery for agriculture and forestry, powered lawn and garden equipment — Symbols for operator controls and other displays — Part 2: Symbols for agricultural tractors and machinery*

ISO 11783-6 *Tractors and machinery for agriculture and forestry — Serial control and communications data network — Part 6: Virtual terminal*

3 Terms and definitions

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

3.1

control

device actuated by an operator to effect a response from the machine, its attachments or its implements

3.2

control actuating force

force exerted at the centre of the control contact surface, perpendicular to that surface and in the direction of its movement, to effect a control function

NOTE This force does not necessarily represent the force typically applied by the operator.

3.3

forward

direction the operator faces while seated in the operator's seat with the machine and the operator's seat in the position for forward travel as defined by the manufacturer

3.4
minimum control strength
ability of a control system to withstand a single excessive application of effort by the operator without being destroyed or having its primary function impeded

3.5
decelerator pedal
control used on certain machines which, when actuated, reduces the engine speed

3.6
hand control
control manipulated by the operator's hand

3.6.1
hand control with finger/wrist activation
hand control manipulated by the movement of one or more fingers or the wrist, with little or no shoulder/elbow motion

3.6.2
hand control with arm activation
hand control gripped by the hand and moved primarily by shoulder/elbow movement

3.7
auxiliary input unit
electronic control unit (ECU) containing one or more VT operator controls for common use and facilitating the machine operation

NOTE See ISO 11783-6.

3.8
non-critical function
machine function which, when actuated, presents a minimal risk to the machine operator or bystanders

3.9
critical function
machine function which, when actuated, can cause an action that could be hazardous to the machine operator or bystanders

3.10
virtual terminal operator control
VT operator control
element of an auxiliary input unit or of a remote key pad, or virtual terminal soft key or touch screen control meeting the requirements of ISO 11783-6 and those specified in Annex B

3.10.1
non-critical VT operator control
VT operator control that is suitable only for the control of non-critical functions

3.10.2
critical VT operator control
VT operator control input suitable for the control of critical functions

NOTE See Annex B.

4 Requirements

4.1 General

4.1.1 Control functions and movements shall be identified by symbols conforming to ISO 3767-1 or ISO 3767-2 so that the operator can determine the proper control function and movement. Identification is not required for controls that have universal recognition by virtue of their shape, location, arrangements or method of actuation, such as a steering wheel, foot-operated clutch pedal, service brake or accelerator pedal.

For identification of manual controls by colour coding, see Annex C.

4.1.2 Foot-operated controls shall be designed to minimize the risk of the foot slipping off the pedal.

4.2 Maximum control actuating force, direction of motion, and location

Guidelines for maximum control actuating forces and generic direction of motion for controls are given in Annex A. Minimum control actuating forces shall be sufficient to avoid inadvertent actuation by the force of a hand or foot resting on the control during anticipated operating conditions.

NOTE ISO 5697 and ISO 10998 specify maximum actuating forces not to be exceeded to meet the braking and steering performance requirements specified by those International Standards. Actuating forces to be applied for normal operation referred to in this International Standard are usually lower.

4.3 Control operation

The operation of controls, if provided on the machine, shall be in accordance with Table 1.

NOTE The control motion indicated in Table 1 represents the motion of several control types such as levers, rocker switches, pairs of push buttons, or sliders. For example, if a pair of buttons or a rocker switch are used to raise and lower the three-point hitch, the interpretation of Table 1, section 8.1, would be to use the button in the upper or rearward position to raise the hitch and the button in the lower or forward position to lower the hitch.

Table 1 — Control operation

No.	Control	Control operation and requirements
1	Engine	
1.1	Starting/stopping engine	Provision shall be made to prevent the engine starter from engaging unless <ul style="list-style-type: none"> a) the traction transmission(s) is (are) in the neutral or parked position or the traction clutch is disengaged, b) the master implement clutch/PTO clutch is disengaged.
1.1.1	Starting engine (rotational switch)	The control shall be rotated clockwise to operate engine starter.
1.1.2	Engine preheater circuit (rotational switch)	If an engine preheater circuit is provided, this control shall occur before or at the starting position. It may be activated by rotating the control anticlockwise (counter-clockwise) or pushing inwards on the control.
1.1.3	Stopping engine (rotational switch)	The control shall be rotated anticlockwise (counter-clockwise) to the stop position.
1.1.4	Stopping engine (mechanical control)	When the stop control is actuated, controls such as levers or buttons shall automatically remain in the stop position without the application of sustained manual effort. Direction of motion shall be pull to stop. The control shall be located within 150 mm of the engine start control. If the stop control is combined with the speed control, it shall be in the direction of and beyond the low idle position.
1.2	Engine speed	
1.2.1	Foot-operated	The control shall be readily accessible to the operator's right foot. The pedal shall be pushed forward and/or downward to increase engine speed.

Table 1 (continued)

No.	Control	Control operation and requirements
1.2.2	Hand-operated variable speed	The control shall be positioned in front of, or to the right of, the operator. Direction of motion shall be in a plane generally parallel to the longitudinal axis of the vehicle. The control shall be moved away from the operator (generally forward) to increase engine speed.
1.2.3	Hand-operated discrete settings	The control shall be positioned in front of, or to the right of, the operator. The actuation of the part of the control which is generally away from the operator shall select higher speed settings.
1.2.4	Decelerator pedal	If provided, the control shall be positioned in front of, or to the right of, the operator and be readily accessible to the operator's right foot. The direction of motion shall be forward and/or downward to decrease engine speed. A foot-operated engine speed control as described in 1.2.1 shall not be provided.
2	Steering (when travelling in a forward direction)	
2.1	Steering wheel	When a steering wheel control is provided, a clockwise rotation shall effect a right turn, and an anticlockwise (counter-clockwise) rotation shall effect a left turn.
2.2	Two levers	When two levers are provided for steering, moving the right-hand lever rearward and/or the left-hand lever forward shall effect a right turn; moving the left-hand lever rearward and/or the right-hand lever forward shall effect a left turn.
2.3	One lever	When one lever is provided for steering, a lateral motion of the lever to the right shall effect a right turn and a lateral motion to the left shall effect a left turn.
3	Brakes	
3.1	Service brake	
3.1.1	Foot-operated	Pedal(s) shall be readily accessible to the operator's right foot. The direction of motion shall be forward and/or downward for engagement. 4.2.1 and 4.2.2 take precedence over this provision. Where separate brake pedals are provided for the independent right-hand and left-hand brake control, it shall be possible to obtain combined control with one foot.
3.2	Park brake	
3.2.1	Hand-operated with finger/wrist activation (e.g. electrical switch)	The control shall be moved forward or away from the operator to apply the park brake. (See Annex A for direction of motion for various surfaces.) The park brake shall remain applied without manual effort. Provision shall be made to prevent unintentional release.
3.2.2	Hand-operated with arm activation	The control shall be pulled to apply the brake. A device shall be provided to retain brake(s) in the applied position. Provision shall be made to prevent unintentional release.
3.2.3	Foot-operated	The direction of motion shall be forward and/or downward for engagement. A device shall be provided to retain brake(s) in the applied position. Provision shall be made to prevent unintentional release.
3.2.4	Combination parking and transmission control	Provision shall be made to prevent unintentional disengagement.
3.3	Secondary braking system	
3.3.1	Hand-operated with finger/wrist activation (e.g. electrical switch)	The control shall be moved forward or away from the operator to apply the secondary brake.
3.3.2	Hand-operated with arm activation	The control shall be pulled to apply the brake.
3.3.3	Foot-operated	The direction of motion shall be forward and/or downward for engagement.

Table 1 (continued)

No.	Control	Control operation and requirements
4	Transmission	
4.1	Clutch (includes combined transmission and PTO) See also PTO control, section 7.	
4.1.1	Foot-operated	The control shall be readily accessible to operator's left foot. The pedal shall be pushed forward and/or downward for disengagement.
4.1.2	Hand-operated with arm activation	The control shall be moved rearward or towards the operator for disengagement. Positive means shall be provided for holding the clutch control in the disengaged position so that it is incapable of being re-engaged unless manually operated. It is recommended that the clutch be operable only from the operator's seat.
4.2	Combination ground speed and forward/reverse direction (continuously variable combined control)	Provision shall be made to prevent unintentional movement of the control from a) neutral to forward or reverse, b) forward to reverse, c) reverse to forward, or, alternatively: the machine motion due to unintentional movement of this control shall be prevented. The neutral position shall be clearly identified and easy to select.
4.2.1	Foot-operated — one pedal, or two pedals longitudinally related to simulate one pedal	The control shall be readily accessible to the operator's right foot. The control shall have the effect of a pedal being pivoted under the operator's foot and shall remain at rest in the neutral position. Forward and/or downward motion of the front of the pedal shall cause forward motion and increasing forward speed; downward motion of the rear of the pedal shall cause reverse motion and increasing reverse speed. The requirement of 3.1.1 does not apply in this case.
4.2.2	Foot-operated — two pedals (side by side)	The control shall be readily accessible to the operator's right foot. Forward and/or downward motion on the outer pedal shall cause rearward motion and increasing rearward speed; forward and/or downward motion on the inner pedal shall cause forward motion and increasing forward speed. The requirement of 3.1.1 does not apply in this case.
4.2.3	Hand-operated	The control shall be moved from neutral position forwards and/or upwards for forward motion and increasing forward speed; rearwards and/or downwards for reverse motion and increasing reverse speed.
4.3	Speed selection	
4.3.1	Hand-operated	The control shall be moved in an upward, forward and/or outward direction to increase speed.
4.3.2	Foot-operated	The control shall be pushed forward or down for higher speed.
4.4	Direction control (forward-reverse non-variable speed)	Provision shall be made to prevent unintentional movement of the control from a) neutral to forward or reverse, b) forward to reverse, c) reverse to forward, or, alternatively: the machine motion due to unintentional movement of this control shall be prevented. The neutral position shall be clearly identified and easy to select.

Table 1 (continued)

No.	Control	Control operation and requirements
4.4.1	Hand-operated	The control shall be moved forward and/or upward for forward motion and moved rearward and/or downward for rearward motion.
5	Master implement control, header or gathering unit clutch	
5.1	Hand-operated	The control shall be moved rearward or downward for disengagement. Provision shall be made to prevent unintentional engagement of the clutch. The control shall be operable only from the operator's seat.
6	Differential lock	The control shall be moved forward or downward for engagement. If the differential lock remains on after release of the actuation mechanism, a means to indicate the differential lock engagement status to the operator shall be provided.
7	PTO (power take off)	
7.1	Clutch	
7.1.1	Foot-operated	The control shall be readily accessible to the operator's left foot. The pedal shall be pushed forward and/or downward for disengagement. In the case of a combined traction-drive/PTO clutch, the PTO disengagement shall be the second stage.
7.1.2	Hand-operated	The control shall be moved upward and/or forward to engage, and downward or rearward to disengage. Provision shall be made to prevent unintentional engagement of the PTO clutch.
8	Implements and auxiliaries	
8.1	Lift mechanism (three-point hitch)	
8.1.1	Hand-operated	The control shall be readily accessible to the operator's right hand and moved upward and/or rearward to raise and downward and/or forward to lower. It shall be possible to lock the control lever(s) or mechanism in the upper position.
8.2	Front loader	
8.2.1	Two levers — lift arm, bucket/attachment	The bucket/attachment control shall be located to the right of the lift arm control. The direction of control motion shall be forward, downward, or away from the operator to lower the lift arm, and in opposite directions to raise the lift arm. The direction of control motion shall be forward, downward, or away from the operator to dump the bucket/attachment, and in opposite directions to roll back the bucket/attachment.
8.2.2	One lever — lift arm, bucket/attachment	The direction of control motion shall be forward, downward, or away from the operator to lower the lift arm, and in opposite directions to raise the lift arm. Movement of the control to the right shall dump the bucket/attachment and movement of the control to the left shall roll back the bucket/attachment.
8.3	Remote hydraulic function	The direction of control motion for a remote hydraulic function shall be forward, downward, or away from the operator to lower or move forward the function; and rearward, upward, or toward the operator to raise or move rearward the function.
9	VT operator controls	VT operator controls shall comply with the requirements of Annex B.

Annex A (informative)

Maximum control actuating force, direction of motion and control location

A.1 Maximum control actuating force

The maximum forces given in Table A.1 should not be exceeded for normal operation. However, emergency situations may require higher forces.

Table A.1 — Maximum control actuating force

Values in newtons

Type of control	Maximum force
Lever fore/aft	230
Lever lateral	100
Lever vertical upwards	400
Pedal-leg/foot operation	450
Pedal-ankle rotation	90
Finger/wrist operation	20
NOTE These forces do not apply to steering and braking systems. Maximum input forces for these systems are specified in ISO 10998 and ISO 5697. See also the Note to 4.2.	

Current machine designs provide lower forces. Minimum control forces are dependent on the control system, and as such are not stated. Minimum control strength should be sufficient to withstand at least five times its typical actuation force.

A.2 Direction of motion

The preferred direction of movement of controls and the anticipated response for the various control locations are shown in Figure A.1.

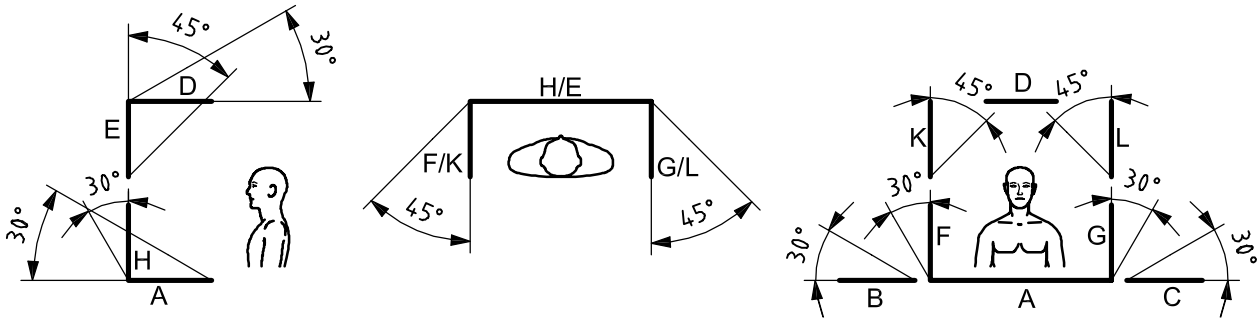
A.3 Control location

A.3.1 It is recommended that a control not be located on a surface which causes ambiguity in the relationship between control movement and function movement.

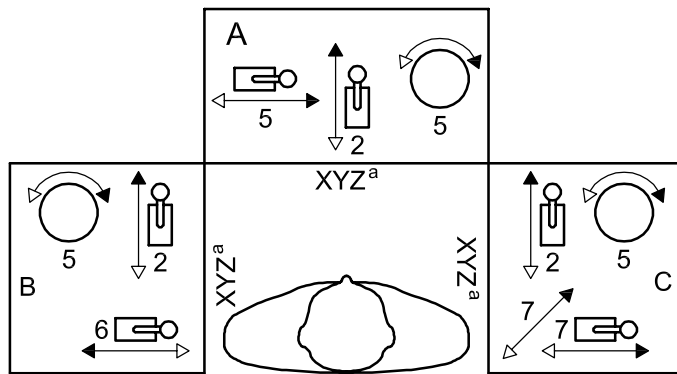
For example, a lever control for a raise-lower function should not be located on a 30° to 60° upward sloping surface, since the recommended direction of the motion changes when it is moved from a vertical to a horizontal plane.

A.3.2 When a sequence of controls is repeated on another panel, the sequence of controls should be the same for each panel.

A.3.3 Control design and spacing should allow unobstructed operation without unintentional actuation of other controls. Overlapping of controls is permissible to provide independent or simultaneous control application.



a) Recommended maximum angles for panels



b) Control direction of movement

Key

1	2	3	4	5	6	7	8	9
Increase	Increase	Increase	Increase	Increase	Increase	Increase	On	Increase
On	On	On	On	On	On	On		
Start	Start	Start	Start	Start	Start	Start		
Forward	Forward	Forward	Backward	Clockwise	Anticlockwise	Clockwise		
Clockwise	Down	Up	Clockwise	Right	Down	Down		
	Lower	Raise			Lower	Lower		
					Left	Right		

—▶ control movement for the response listed

—▷ opposite response to the black-headed arrows

Panels — General

Panels H, C, B, and J constitute the prime work areas.

Overhead panels should be used for infrequently operated controls.

Panels — Angle recommendations

Overhead panel D should be horizontal or up to 30° above horizontal.

High panel E should be angled 45° or less from vertical.

Vertical panels F and G should be angled less than 30°.

Horizontal control panels A, B, and C may be tilted up to 30°.

Controls — General

Manual liquid valves rotate clockwise to shut off flow.

Rotary or push-pull controls may pull for “ON” and push for “OFF”.

Lever motion indicated in the figure represents the motion of several control types such as levers, rocker switches, sliders and pairs of push buttons.

Control — Location and movement recommendations

Panels are shown for an operator who does not rotate. If controls are designed with operator rotation in mind, panels B and C should be identical to panel A.

If operator can turn to face side panels F and G, all controls should be similar to H.

In panels B and C, right-left actuated control usage can lead to control ambiguity and should be avoided.

If a rotary control on panel G is related to, or operated simultaneously with, a rotary control on panel F, the control motion should be opposite to that shown on G for backward, increase, on, and start.

Levers on panels B and C may be oriented at an angle to provide movement away from, and towards, the operator provided the general principles of operation are met.

^a Sequential order for related controls: if a normal or natural order exists for related controls, the order on different panels should be in the sequence shown.

Figure A.1 — Panel orientation and control direction of movement

Annex B (normative)

Operator controls associated with virtual terminals

B.1 General

Operator controls associated with virtual terminals include, but are not limited to, auxiliary input units as defined in ISO 11783-6, proprietary control units, soft keys and data masks (e.g. buttons). These controls also include the interface elements of the virtual terminal that activate the soft keys and data mask objects such as bezel buttons, touch screens or remote keypads. Critical functions shall only be controlled by critical VT operator controls.

B.2 Marking and labelling of controls

B.2.1 Markings

B.2.1.1 Each VT operator control shall be permanently marked. VT operator controls that have more than one actuation position or direction (e.g. joysticks, multi-position switches, etc.) shall be marked for each actuation position or direction. Each VT operator control designator displayed on the virtual terminal shall display the corresponding marking(s).

NOTE Soft keys physically located relative to the VT operator control designator displayed on the screen such that the relationship is clear need not be provided with additional markings.

B.2.1.2 Auxiliary input units and other input units intended to be installed by the operator shall be marked to show the intended mounting orientation.

B.2.2 Labels

Auxiliary input units shall be designed in such a way as to allow 20 mm square or larger labels to be applied either on or near to the VT operator control. Other data mask objects that can control critical functions (e.g. touch screen button objects) shall be provided with labels which are clearly visible. Appropriate labels shall be provided by the function owner (e.g. implement). Symbols, when used, shall conform to ISO 3767-1 or ISO 3767-2.

NOTE The label area for virtual terminal soft keys is provided in the soft key designator specified in ISO 11783-6.

B.3 Installation

Manufacturers of input units intended to be installed by others (e.g. auxiliary input units) shall publish and provide installation instructions to ensure the input unit is mounted in the correct orientation and in such a way as not to interfere with other controls and reduce the likelihood of inadvertent actuation of VT operator controls. Wired input units intended to be used within the operator station shall be equipped with connection cables of appropriate length to allow proper mounting, but not so long as to allow the unit to be operated outside of the operator station.

B.4 Protection against inadvertent actuation

Each critical VT operator control shall be provided with a means of protecting against inadvertent actuation. Such means may include more than one motion to activate the control, shielding around the control, or other methods that fulfil the intent of this requirement.

B.5 Additional requirements for pointing units including touch screen controls

Pointing unit controls need requirements for use in addition to the requirements given in this International Standard.

- Activation of a function may occur on either depression/touch or upon depression/touch and valid release. Activation upon depression/touch should be avoided except in special circumstances (e.g. a control which serves as an emergency stop, a press-and-hold button used for setting a changeable value, etc.).
- A valid release shall only be achieved if the release occurs in the object on the screen that was touched (e.g. if the operator touches a touch screen button object and slides his finger off the button object, a valid release has not occurred).

B.6 Operator's manual

Information shall be provided with each unit containing VT operator controls, addressing at a minimum the following items:

- a) mounting instructions, including selection of appropriate locations and preferred mounting orientation;
- b) warnings about the hazards associated with operating the input unit in inappropriate locations;
- c) instructions as required to properly identify the markings on the VT operator controls and to allow the user to properly assign the control to appropriate critical and non-critical functions;
- d) instructions on how to apply appropriate labels to the VT operator controls;
- e) an appropriate warning about the hazards of operating VT operator controls without appropriate labels;
- f) information about the number of each type of VT operator control provided and the types of functions supported by each type of control;
- g) instructions for reading and reviewing the virtual terminal manual to determine its procedure for setting and reviewing VT operator control assignments;
- h) information that this operator's manual only covers the VT operator control unit and that the user should not attempt to use or assign the VT operator controls prior to reading and reviewing the operator's manuals of all other connected components (tractor, implement, virtual terminal, etc.);
- i) an appropriate warning that the person who makes the assignments is responsible for ensuring that the correct labels for all VT operator controls are installed prior to operating the VT operator control unit and that these labels shall be replaced as necessary when assignments are changed;
- j) an appropriate warning that the person who makes or changes the assignments of the VT operator control unit shall inform all operators of the VT operator control unit of the new or changed assignments.

Annex C (informative)

Identification of hand controls by colour coding

C.1 General

C.1.1 For the purposes of this annex, hand controls include, but are not limited to, levers, switches, knobs, handles and buttons that the operator manipulates to activate or control machine functions.

C.1.2 When new types of hand control are adopted or combination controls are used, the colour shall be selected in accordance with the primary function.

C.1.3 If it is not practical to colour code the control, it is sufficient to colour code either the area surrounding the control or the identification of that control rather than the control.

C.1.4 Colour coding does not replace the need for identification by symbols. Controls for functions that are not obvious shall be identified in accordance with ISO 3767-1 and ISO 3767-2.

C.2 Colour coding

The colour coding shall be in accordance with Table C.1.

Figure C.1 — Colour coding

Colour		Controls
C.2.1	Red	Single-function engine stop controls. Where key switches, ignition switches or hand throttles are used to stop the engines, the “off” or “stop” positions shall be indicated with red lettering and/or symbols.
C.2.2	Orange	Machine ground motion controls only. EXAMPLE Engine speed controls, transmission controls, parking brakes, park-locks, independent emergency brakes. Exceptions: — where the engine speed and engine stop controls are combined, the controls may be red; — steering wheels or steering controls may be black or any colour other than red or yellow.
C.2.3	Yellow	Function controls which involve the engagement of mechanisms only. EXAMPLE PTO, separators, cutterheads, feed rolls, picking units, elevators, unloading augers.
C.2.4	Black or any other colour except red, orange or yellow	All controls not covered by C.2.2, C.2.2 or C.2.3. EXAMPLE 1 Component lift or position such as implement hitch, header height, blade shift and reel lift. EXAMPLE 2 Control for unloading components such as spout cap, unloading auger swing and bin dump. EXAMPLE 3 Setting and adjustment mechanisms such as chokes, cylinder speed, concave space, seat adjustment, steering column, transmission disconnect, concave lock, lift stops, rockshaft stops, reel speed, and flow dividers. EXAMPLE 4 Machine lights such as headlights, work lights or floodlights, taillights, flashers, and turn signals. EXAMPLE 5 Cabin comfort such as pressurizer, cooling, heating and windshield wipers.

Bibliography

- [1] ISO 5697, *Agricultural and forestry vehicles — Determination of braking performance*
- [2] ISO 10998, *Agricultural tractors — Requirements for steering*

