TECHNICAL SPECIFICATION

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

Tracteurs et machines agricoles et forestières automotrices — Commandes de l'opérateur — Forces de manœuvre, déplacement, emplacement et mode de fonctionnement

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Contents

Page

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 3.

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.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of normative document:

— an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;

— an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

An ISO/PAS or ISO/TS is reviewed after three years with a view to deciding whether it should be confirmed for a further three years, revised to become an International Standard, or withdrawn. In the case of a confirmed ISO/PAS or ISO/TS, it is reviewed again after six years at which time it has to be either transposed into an International Standard or withdrawn.

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

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

This first edition of ISO/TS 15077 cancels and replaces ISO/TR 3778:1997, ISO 3789-1:1982 and ISO 3789-2:1982, which have been technically revised.

Annex A of this Technical Specification is for information only.

Introduction

The provisions of this Technical Specification were derived from experience, current practice, human factors literature and existing standards. In addition to recommendations including those for control actuation forces and the generic direction of motion given in annex A, provisions for controls common to many agricultural vehicles are provided.

The major development covered by this Technical Specification is the relationship between the control actuation force, control displacement, control location and operational frequency.

The definition of controls as either frequently-operated or infrequently-operated was chosen based on the experience of manufacturers. Such a division of controls into two classes according to their frequency of use was determined to be sufficient for establishing a reasonable relationship between control resistance and control displacement.

The values selected for actuation force and displacement are based on published human factors values from a number of sources. In general, the frequently-operated control maximum values are based on continuous maximum operation values and the infrequently-operated controls on the maximum value that could be maintained for a short duration.

As displacements increase, the operator actuation force capability for a frequently-operated control decreases due to fatigue. Based on experience and evaluation of controls deemed either acceptable or unacceptable, it was determined that an ellipse curve like the one given in this Technical Specification established a reasonable boundary for defining the relationship between control actuation force and control displacement.

The guidelines and criteria presented in this Technical Specification apply to most conditions. Each condition, however, must be evaluated for its own function and its relationship to other functions if the desired operation action is to be achieved in both normal and emergency situations. The values for control displacement and resistance apply only to that which is required to achieve the desired performance of the function being controlled for the 5th percentile adult female to the 95th percentile adult male.

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

1 Scope

This Technical Specification gives the preferred method of operation, together with recommendations and requirements for the actuation, displacement and location, of operator controls installed on tractors and self-propelled machinery used in agriculture and forestry. It provides design guidance on actuation forces for hand and foot controls in relation to their displacement, frequency of use and location, and is applicable to the typical operation of these tractors and self-propelled machines by upright-seated operators. It is not applicable to powered lawn and garden equipment or to purpose-built forestry machines as defined in ISO 6814.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this Technical Specification. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this Technical Specification are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 5697, *Agricultural and forestry vehicles — Determination of braking performance*

ISO 10998, *Agricultural wheeled tractors — Steering requirements*

3 Terms and definitions

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

3.1
control
device actuated by a person to effect a response from the machine, its equipment or tools

3.2
frequently-operated control
control with an average operational interval of 5 min or less between actuation during a normal operational cycle

3.3
infrequently-operated control
control with an average operational interval of more than 5 min between actuation during a normal operational cycle

3.4
control displacement
movement of a control through its operational range

3.5
control actuation 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 that typically applied by the operator.

3.6
control actuating torque
⟨rotary controls⟩ torque exerted on a control in order to effect a control function

3.7
linear control displacement
length of the locus of the point of application of the control actuation force in effecting a single control function

3.8
angular control displacement
⟨rotary controls⟩ angle of the arc subtended by a point fixed on the perimeter of a control in effecting a single control function

NOTE This angle may be greater than 360°, i.e. one or more whole turns.

3.9
control zone
volume that the control describes in its movement when properly adjusted

3.10
normal actuation force
control actuation force applied to achieve the desired control function under normal operating conditions

3.11
minimum actuation force
control actuation force necessary, when applied, for functional input to be sensed by the operator

3.12
forward
direction faced by the operator while seated in the operator's seat with the machine and the seat in the position for straight, forward travel, as defined by the manufacturer

3.13
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

3.14
zone of comfort
preferred area in which are located hand and foot controls that an operator large or small can reach comfortably

3.15
zone of reach
area in which are located hand and foot controls that an operator large or small can reach from the seated position, even when to do this it is necessary for the operator to rotate or lean forward and to one side or the other

3.16
decelerator pedal
control used on certain machines which, when actuated, reduces the machine's engine speed

4 Control actuation force and displacement

4.1 Recommendations for control actuation forces and generic direction of motion are given in annex A. Minimum control actuation forces should be sufficient to avoid inadvertent actuation by the force of a hand or foot resting on the control during anticipated operating conditions.

NOTE Hold-to-run controls are considered as frequently-operated controls.

4.2 For steering effort requirements, see ISO 10998.

4.3 When testing brake controls, which shall be performed in accordance with ISO 5697, the control actuation force shall not exceed

— 400 N for hand-operated (palm grasp), pull-motion controls, and

— 600 N for foot pedals.

NOTE These actuation forces for brake controls are not applicable to the 5th percentile female population. For example, the actuation forces for the brake control are applicable only to a portion of the female population and some males. Lower applied forces will cause less braking output and, as a consequence, longer stopping distances.

5 Control location and method of operation

NOTE Operating requirements for the controls common to many agricultural vehicles are given below. Reference to hand-operated controls also includes finger-operated controls, unless stated otherwise.

Control		Location and operation
5.1	**Engine**	
5.1.1	**Starting**	Provision shall be made to prevent starting the engine unless 1) the traction transmission or transmissions are in the neutral or parked position, or 2) the traction clutch is disengaged.
5.1.1.1	**Ignition switch** (if separate from starter switch)	Move the control to the “on” position.
5.1.1.2	**Starter switch** (if separate from ignition switch)	Move the control to the “start” position.
5.1.1.3	**Starter/ignition switch** (spark ignition)	Move the control to “start” position. If a rotational switch is provided, rotate it clockwise to operate the engine starter.
5.1.1.4	**Starter switch** (compression ignition)	Move the control to “start” position. If a rotational switch is provided, rotate it clockwise to operate the engine starter. If an engine preheater circuit is provided, this control shall activate either before or at the starting position, or else may be activated by rotating the control in an anticlockwise direction.
5.1.2	**Engine speed**	
5.1.2.1	**Foot-operated**	The control should be readily accessible to the operator’s right foot. Push the pedal forward or downward, or both, to increase engine speed. If provided, a decelerator pedal should be readily accessible to either the operator’s right or left foot, but not necessarily to both. It should be located so that it can be operated with either foot, and with the direction of motion forward or downward, or both, to decrease engine speed. A decelerator pedal is to be used in combination with a hand-operated accelerator control; a foot-operated accelerator pedal shall not be provided in conjunction with a decelerator pedal.
5.1.2.2	**Hand-operated**	The control should be placed in front, or to the right, of the operator. The direction of motion is in a plane generally parallel to the longitudinal axis of the vehicle. The direction of motion to increase engine speed is away from the operator (generally forward).

Control		Location and operation
5.1.3	**Stopping the engine**	
5.1.3.1	**Spark ignition**	Rotate the starter ignition switch anticlockwise to the “off” (open circuit) position.
5.1.3.2	**Compression ignition**	Move the control to the “stop” position. The control shall automatically remain in this position without the application of sustained manual effort. If the stop control is combined with the speed control, movement shall be in the direction of, and beyond, the low idle position.
5.2	**Steering**	When a steering-wheel control is provided, a clockwise rotation shall effect a right turn, an anticlockwise rotation a left turn. When two levers are provided for steering, the right-hand lever shall move rearward to effect a right turn and the left-hand lever shall move rearward to effect a left turn. 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.
5.3	**Brakes**	
5.3.1	**Service brake**	
5.3.1.1	**Foot-operated**	The pedal or pedals should be readily accessible to the operator’s right foot. The direction of motion shall be generally forward, downward or both, for engagement. Where separate brake pedals are provided on wheeled tractors for independent right-hand and left-hand brake control it shall be possible to obtain combined control.
5.3.1.2	**Hand-operated**	A pull motion shall apply the brake.
5.3.2	**Parking brake**	
5.3.2.1	**Finger-operated**	Push to apply the brake. A device shall be provided to retain brakes in the applied position. Provision shall be made to prevent unintentional release.
5.3.2.2	**Hand-operated**	A pull motion shall apply the brake. A device shall be provided to retain brakes in the applied position. Provision shall be made to prevent unintentional release.
5.3.2.3	**Foot-operated**	The control shall be located to the left of the service brake pedal and should be convenient to the left foot. The direction of motion shall be generally forward or downward, or both, for engagement. A device shall be provided to retain brakes in the applied position. Provision shall be made to prevent unintentional release.
5.3.2.4	**Combination parking and transmission control**	Provision shall be made to prevent unintentional movement of the control from the “park” position.
5.3.3	**Secondary braking system**	
5.3.3.1	**Hand-operated**	A pull motion shall apply the brake.
5.3.3.2	**Foot-operated**	The control should be located to the left of the service brake pedal and convenient to the left foot. The direction of motion shall be generally forward or downward, or both, for engagement.

Control		Location and operation
5.4	**Transmission**	
5.4.1	**Clutch** (includes combined transmission and PTO). See also PTO control.	
5.4.1.1	**Foot-operated**	It should be convenient to the operator's left foot. Push pedal forward or downward, or both, for disengagement.
5.4.1.2	**Hand-operated**	Move the control 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.
5.4.2	**Combination ground speed and direction** (continuously variable combined control)	
5.4.2.1	**General**	Provision shall be made to prevent unintentional movement of the control from "neutral" into gear, forward to reverse, and reverse to forward. A positive neutral position shall be provided.
5.4.2.2	**Foot-operated — one control**	It should be convenient 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 or downward motion of the front of the pedal or both shall cause forward motion and increasing forward speed; downward motion of the rear of the pedal shall cause reverse motion and increasing reverse speed.
5.4.2.3	**Foot-operated — two pedals**	It should be convenient to the operator's right foot. Forward or downward motion of the outer pedal or both shall cause rearward motion and increasing rearward speed. Forward or downward motion of the inner pedal or both shall cause forward motion and increasing forward speed.
5.4.2.4	**Hand-operated**	Move the control from the neutral position forwards or upwards or both for forward motion and increasing forward speed. Move the control from the neutral position rearwards or downwards or both for reverse motion and increasing reverse speed.
5.4.3	**Gear selection**	
5.4.3.1	**Hand-operated**	If the control is operated in-line, move the control from "neutral" in an upward, forward or outward direction, or all these, to select gears giving increased forward speeds. Move the control from "neutral" in a rearward, downward or inward direction, or all these, to select gears giving increased reverse speeds. If a neutral position is included, provision shall be made to prevent unintentional movement of the control from "neutral" into gear.
5.4.4	**Direction control** (forward–reverse non-variable speed)	
5.4.4.1	**Hand-operated**	Move the control generally forwards or upwards or both, for forward motion, and move it generally rearwards or downwards or both for rearward motion. Provision shall be made to prevent unintentional movement of the control from forward to reverse and reverse to forward. If a neutral position is provided, provision shall be made to prevent unintentional movement of the control from neutral into gear.