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**Self-propelled agricultural  
machinery — Assessment of stability —**

**Part 1:  
Principles**

*Machines agricoles automotrices — Évaluation de la stabilité —  
Partie 1: Principes*



Reference number  
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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. [www.iso.org/directives](http://www.iso.org/directives)

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received. [www.iso.org/patents](http://www.iso.org/patents)

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The committee responsible for this document is ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 3, *Safety and comfort*.

ISO 16231 consists of the following parts, under the general title *Self-propelled agricultural machinery — Assessment of stability*:

— *Part 1: Principles*

The following part is under preparation:

— *Part 2: Calculations and test procedures*

## Introduction

Self-propelled agricultural machinery with a ride-on operator (driver) can expose the operator to the hazard of rolling or tipping over during the intended operation. A risk assessment should determine whether this hazard applies to a particular machine and, when appropriate, the protective measures to be used in order to avoid or minimize this hazard for the ride-on operator. For many machines, this risk assessment will be reflected in the requirements of a machine-specific standard.

The risk assessment should consider the operating conditions in which the machine is intended to be used, the physical properties of the machine and the required skills to operate the machine as well as any other parameter which can have an impact on the risk for rollover or tip-over.



# Self-propelled agricultural machinery — Assessment of stability —

## Part 1: Principles

### 1 Scope

This part of ISO 16231 specifies principles for the assessment of stability with respect to the design and construction of self-propelled ride-on machines used in agriculture and the hazard of rolling over or tipping over, or both, when the machine is used as intended and under the conditions foreseeable by the manufacturer. In addition, it specifies the type of information on safe working practices (including residual risks) to be provided by the manufacturer.

This part of ISO 16231 is not applicable to:

- machines with an unladen mass lower than 400 kg;
- machines covered by other machine specific standards dealing with the protection against rollover and tip-over (e.g. agricultural tractors, forestry tractors);
- hazards associated with road transport operations;
- free fall events;
- rollover as a result of impact collisions.

This part of ISO 16231 is not applicable to machines manufactured before the date of its publication.

### 2 Normative references

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

ISO 3776-1:2006, *Tractors and machinery for agriculture — Seat belts — Part 1: Anchorage location requirements*

ISO 3776-2:2013, *Tractors and machinery for agriculture — Seat belts — Part 2: Anchorage strength requirements*

ISO 3776-3:2009, *Tractors and machinery for agriculture — Seat belts — Part 3: Requirements for assemblies*

ISO 4254-1:2013, *Agricultural machinery — Safety — Part 1: General requirements*

### 3 Terms and definitions

For the purposes of this document, the terms and definitions of ISO 4254-1:2013 and the following apply.

**3.1**  
**automatic protective system**  
**APS**

any automatic system, controlling functions of the machine or engaging devices, without intervention from the operator, to minimize the likelihood of overturning or tip-over

Note 1 to entry: For example, this means systems which bring the machine to a safe mode, when the allowed slope or stability limits would be exceeded, by reducing for instance speed or height or changing the inclination of the machine. It includes any automatic deployable structures.

**3.2**  
**roll-over protective structure**  
**ROPS**

framework that minimizes the likelihood of driver injury resulting from accidental overturning

Note 1 to entry: The ROPS is characterized by the provision of space for a deflection limiting volume, either inside the envelope of the structure or within a space bounded by a series of straight lines from the outer edges of the structure to any part of the machine that might come into contact with flat ground and that is capable of supporting the machine in that position if the machine overturns.

**3.3**  
**self-protective structure**  
**SPS**

structural components of the machine, with sufficient strength to provide a deflection limiting volume, if the machine overturns

**3.4**  
**self-protective devices**  
**SPD**

mounted attachment(s) or other device(s) fitted to the base machine which prevent the machine from rollover or tip-over, or both by for example its mass, shape, position

**3.5**  
**slope**  
grade

inclination of the land surface from the horizontal; percentage (%) slope =  $\tan(\text{degrees slope}) \cdot 100$ ;  
degree slope =  $\tan^{-1}((\%) \text{ slope} / 100)$

**3.6**  
**static overturning angle**  
**SOA**

<for each direction> angle of tilt on which the vertical projection of the centre of gravity (COG) falls beyond the area of stability

**3.7**  
**required static stability angle**  
**RSSA**

<for each machine/application, and for each direction> required calculated slope on which the machine is stable

**3.8**  
**rollover**

loss of machine stability characterized by a clockwise or counter clockwise rotation of more than 90 degrees around either both the longitudinal or lateral axis of the machine

**3.9**  
**tip-over**

loss of machine stability characterized by a clockwise or counter clockwise rotation of no more than 90 degrees around either both the longitudinal or lateral axis of the machine



### 3.10 safety factor SF

factor intended to take into account the dynamic effects on the stability and the punctual variations of the ground conditions (e.g. holes or bumps)

## 4 Principles

### 4.1 Risk assessment

A risk assessment shall be carried out to determine whether there is a significant risk of rollover or tip-over. The risk assessment shall consider the following aspects:

- intended use of the machine (see [Clause 6](#)), e.g.
  - operations to be carried out;
  - typical operating and ground conditions (e.g. slope);
- physical properties of the machine (e.g. masses, dimensions) under operating conditions;
- machine limits;
- operator (e.g. education, training, experience, ability).

### 4.2 Protective measures

If the risk assessment shows that there is a need to reduce the risk of rollover or tip-over, or both, for the type of machine under consideration, the machine shall be

- a) designed so that its Static Overturning Angle (SOA) is equal or greater than the Required Static Stability Angle (RSSA) which shall include a suitable safety factor; or
- b) equipped with Self-Protective Device (SPD); or
- c) equipped with an Automatic Protective System (APS); or
- d) provided with means to afford an appropriate deflection limiting volume in case of rollover and/or tip-over, or both. Examples for such means are
  - 1) Self-Protective Structure, or
  - 2) additional structure such as a Roll-Over Protective Structure.

If the protective measure applied relies on the provision of a deflection limiting volume, the machine shall be equipped with an operator restraint system, e.g. seat belt and seat-belt anchorages in accordance with ISO 3776 (Parts 1 to 3).

### 4.3 Information for use

Appropriate information for use and operation of the machine shall be provided in the operator's manual (see [Clause 6](#)).

## 5 Verification of safety requirements and/or protective measures

The specified procedures given in [Table 1](#) shall be applied for the relevant directions (e.g. forward, rearward, to the sides).

**Table 1 — List of safety requirements and/or protective measures and their verification requirements**

Clause / Subclause	Verification			
	Inspection	Measurement	Functional test	Procedure / reference
4.2 a)	—	X	—	Measure or calculate SOA and compare with RSSA <sup>a</sup>
4.2 b)	—	X	—	Measure or calculate the maximum machine angle allowed by the mounted attachment(s) or other device(s) and compare this angle with the RSSA
4.2 c)	X	—	X	
4.2 d) 1)	—	X	—	<sup>a</sup>
4.2 d) 2)	X	X	—	“Inspection” in case of labelled structure; “measurement” in other cases <sup>a</sup>
4.3	X	—	—	—

<sup>a</sup> ISO 16231-2 (under preparation) may provide appropriate information. In the absence of such, the manufacturer will establish the RSSA value based on the manufacturer’s assessment of the machine’s intended usage and its operating conditions.

## 6 Operator’s manual

The operator’s manual shall provide safety instructions with respect to rollover or tip-over hazards. In particular, the following information shall be included, if relevant:

- a) rollover hazards related to embankments;
- b) rollover hazards related to passing over weak/fragile bridge-heads and bridge floors in poor condition;
- c) the effects of raised and/or extended components of the machine such as root bunkers, grain tank extensions, folded headers, raised cotton basket, folded spray booms, etc. on its stability;
- d) the limits of longitudinal and transversal slope on which the machine is allowed to work and a warning not to exceed these limits;
- e) an instruction to use the operator restraint system, if applicable;
- f) a warning to ensure that attachments of the type fulfilling the function specified by 4.2 b) are fitted securely to the base machine, so that they can fulfill their supporting function by increasing stability or limiting movement to prevent tipping, if applicable;
- g) a warning that high speed, abrupt manoeuvres and fast tight cornering can increase the risk to rollover;
- h) a warning to limit the speed of the machine and to observe any additional recommendations when travelling down steep hills;
- i) a warning to use body levelling or hill side compensation system, if provided, at all times in the field;
- j) a warning to follow the instructions of the manufacturer regarding ballasting of the machine for the different configurations of the machine.



