



**International
Standard**

ISO 3991

**Agricultural machinery — Robotic
feed systems — Safety**

*Matériel agricole — Systèmes d'alimentation robotisés —
Sécurité*

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Contents

Page

Foreword	v
Introduction	vi
1 Scope	1
2 Normative references	2
3 Terms and definitions	3
4 Safety requirements and/or protective measures	5
4.1 General	5
4.2 Storage of feed	6
4.2.1 General	6
4.2.2 Feed storage devices	6
4.2.3 Feed storage area	7
4.3 Loading	7
4.4 Checking of the mixing	8
4.5 Travelling	8
4.5.1 General	8
4.5.2 Area of travelling and pathways	8
4.5.3 Safety distance along the route	8
4.6 MFU	10
4.6.1 General	10
4.6.2 Obstacle protective system	11
4.6.3 Braking system	16
4.6.4 Audible alarm	16
4.6.5 Visual alarm	16
4.6.6 Additional requirements for hanging MFU	17
4.7 Distributing	17
4.8 Pushing feed/Cleaning	18
4.9 Electrical safety	18
4.9.1 General	18
4.9.2 Battery charging	18
4.10 Controls	19
4.10.1 Location	19
4.10.2 Controls for operational modes	19
4.11 Operational modes	20
4.11.1 General	20
4.11.2 Manual mode	20
4.11.3 Autonomous mode	20
4.11.4 Semi-autonomous robotic feed system	20
4.11.5 Service mode	21
4.12 Service and maintenance	21
4.13 Emergency stop devices	21
4.14 Fire and explosion	21
4.15 Magnets and magnetic fields	22
5 System integration	22
5.1 General	22
5.2 Layout design	22
5.3 Zones	23
5.3.1 Common zone	23
5.3.2 Caution zone	23
5.3.3 Restricted zone	23
6 Verification of the safety requirements and/or protective measures	23
7 Information for use	26
7.1 Operators manual	26

ISO 3991:2025(en)

7.2	Layout.....	26
7.3	Marking.....	27
7.3.1	General.....	27
7.3.2	Safety signs	27
Annex A	(informative) Examples of robotic feed system	29
Annex B	(informative) List of significant hazards	31
Annex C	(normative) Safety functions of RFS requiring functional safety analysis	34

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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 document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 3, *Safety and comfort*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 144, *Tractors and machinery for agriculture and forestry*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

This document is a type-C standard as specified in ISO 12100:2010.

This document is of relevance, in particular, for the following stakeholder groups representing the market players with regard to machinery safety:

- machine manufacturers (small, medium and large enterprises);
- health and safety bodies (regulators, accident prevention organizations, market surveillance, etc.)

Others can be affected by the level of machinery safety achieved with the means of the document by the above-mentioned stakeholder groups:

- machine users/employers (small, medium and large enterprises);
- machine users/employees (e.g. trade unions, organizations for people with special needs);
- service providers, e.g. for maintenance (small, medium and large enterprises);
- consumers (in case of machinery intended for use by consumers).

The above-mentioned stakeholder groups have been given the possibility to participate at the drafting process of this document.

The machinery concerned and the extent to which hazards, hazardous situations and events are covered are indicated in the scope of this document.

When provisions of this type C standard are different from those which are stated in type A or B standards, the provisions of this type C standard take precedence over the provisions of the other standards, for machines that have been designed and built according to the provisions of this type C standard.

The purpose of this document is to establish specific design principles for semi-autonomous and autonomous functions of robotic feed systems (RFS) agricultural machinery. The application of other type C standards which deal with relevant significant hazards to the machinery covered in the scope of this document is explained in [Clause 4](#).

The requirements of this document concern designers, manufacturers and their authorized representatives of feed systems. This document also includes information to be provided by the manufacturer to the user.

Agricultural machinery — Robotic feed systems — Safety

1 Scope

This document specifies the safety requirements and their verification for the design and construction of robotic feed systems (RFS) (see [Annex A](#)), which distribute feed and perform at least one of the following functions without the need of human interaction:

- storing of feed;
- loading of mobile feed unit (MFU);
- mixing;
- travelling;
- cleaning (residual feed);
- pushing feed.

Additionally, it provides the type of information, to be provided by the manufacturer, on safe working practices (including information about residual risks).

This document is for feeding livestock (e.g. cows, sheep, pigs).

This document does not apply to:

- systems designed to be used at a fixed location and that discharge feed at a remote location (e.g. chain conveyor feed systems, belt conveyor feed systems or liquid feed systems);
- tractors;
- systems designed for field application.

This document deals with all the significant hazards, hazardous situations and events relevant to RFS, see [Annex B](#), when they are used as intended and under the conditions of misuse, which are reasonably foreseeable, by the manufacturer as listed in [Clause 4](#), except for the hazards arising from:

- internal combustion engines of RFS;
- requirements for the connections to the main electric power supply;
- RFS with interchangeable equipment;
- emission of airborne noise.

NOTE 1 Hazards related to internal combustion engines of robotic feed systems (e.g. exhaust emissions in buildings) will be considered in separate standards

NOTE 2 The main electric power supply is subject to national regulations or codes

NOTE 3 Sudden loud noises may cause farm animals to become startled. It is advised to consider this with the design of the RFS.

Environmental aspects (except noise) have not been considered in this document.

This document is not applicable to feed systems manufactured before the date of its publication.

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 3691-4:2023, *Industrial trucks — Safety requirements and verification — Part 4: Driverless industrial trucks and their systems*

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

ISO 7010:2019, *Graphical symbols — Safety colours and safety signs — Registered safety signs*

ISO 7731:2003, *Ergonomics — Danger signals for public and work areas — Auditory danger signals*

ISO 11684:2023, *Tractors, machinery for agriculture and forestry, powered lawn and garden equipment — Safety labels — General principles*

ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

ISO 13849-1:2023, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design*

ISO 13849-2:2012, *Safety of machinery — Safety-related parts of control systems — Part 2: Validation*

ISO 13850:2015, *Safety of machinery — Emergency stop function — Principles for design*

ISO 13856-2:2013, *Safety of machinery — Pressure-sensitive protective devices — Part 2: General principles for design and testing of pressure-sensitive edges and pressure-sensitive bars*

ISO 13856-3:2013, *Safety of machinery — Pressure-sensitive protective devices — Part 3: General principles for design and testing of pressure-sensitive bumpers, plates, wires and similar devices*

ISO 13857:2019, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs*

ISO 14119:2024, *Safety of machinery — Interlocking devices associated with guards — Principles for design and selection*

ISO 14120:2015, *Safety of machinery — Guards — General requirements for the design and construction of fixed and movable guards*

ISO 15817:2012, *Earth-moving machinery — Safety requirements for remote operator control systems*

ISO 16230-1:2015, *Agricultural machinery and tractors — Safety of higher voltage electrical and electronic components and systems — Part 1: General requirements*

ISO 16231-2:2015, *Self-propelled agricultural machinery — Assessment of stability — Part 2: Determination of static stability and test procedures*

ISO 18497-1:2024, *Agricultural machinery and tractors — Safety of partially automated, semi-autonomous and autonomous machinery — Part 1: Machine design principles and vocabulary*

ISO 25119-1:2018/Amd 1:2020, *Tractors and machinery for agriculture and forestry — Safety-related parts of control systems — Part 1: General principles for design and development — Amendment 1*

ISO 25119-2:2019, *Tractors and machinery for agriculture and forestry — Safety-related parts of control systems — Part 2: Concept phase*

ISO 25119-3:2018/Amd 1:2020, *Tractors and machinery for agriculture and forestry — Safety-related parts of control systems — Part 3: Series development, hardware and software — Amendment 1*

ISO 25119-4:2018, *Tractors and machinery for agriculture and forestry — Safety-related parts of control systems — Part 4: Production, operation, modification and supporting processes*

ISO 25119-4:2018/Amd 1:2020, *Tractors and machinery for agriculture and forestry — Safety-related parts of control systems — Part 4: Production, operation, modification and supporting processes — Amendment 1*

EN 703:2021, *Agricultural machinery — Safety — Silage loading, mixing and/or chopping and distributing machines*

EN 1175:2020, *Safety of industrial trucks — Electrical/ electronic requirements*

IEC 60204-1:2016, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

IEC 60825-1:2014, *Safety of laser products — Part 1: Equipment classification and requirements*

IEC 61000-6-2:2016, *Electromagnetic compatibility (EMC) — Part 6-2: Generic standards — Immunity standard for industrial environments*

IEC 61000-6-4:2018, *Electromagnetic compatibility (EMC) — Part 6-4: Generic standards — Emission standard for industrial environments*

IEC 61496-1:2020, *Safety of machinery — Electro-sensitive protective equipment — Part 1: General requirements and tests*

IEC 61496-2:2020, *Safety of machinery — Electro-sensitive protective equipment — Part 2: Particular requirements for equipment using active opto-electronic protective devices*

IEC 62485-6:2021, *Safety requirements for secondary batteries and battery installations — Part 6: Lithium-ion batteries for traction applications*

IEC 62619:2022, *Secondary cells and batteries containing alkaline or other non-acid electrolytes — Safety requirements for secondary lithium cells and batteries, for use in industrial applications*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 18497-1:2024 and the following apply.

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1 robotic feed system RFS

feed system, either semi-autonomous or autonomous, consisting of various machinery performing the necessary functions to feed livestock

3.1.1 semi-autonomous robotic feed system

system comprising *feed robotic device(s)* (3.2.1) and any machinery, equipment, devices, or sensors supporting the feed robotic device(s) performing its feed task

3.1.2 autonomous robotic feed system

system comprising *feed robot(s)* (3.2.2) and any machinery, equipment, devices, or sensors supporting the feed robot performing its feed task

3.2 mobile feed unit MFU

specific mobile device used to deploy the feed to the livestock, which is either a *feed robotic device* (3.2.1) or a *feed robot* (3.2.2) as part of an *RFS* (3.1)

3.2.1

feed robotic device

actuated programmable mechanism fulfilling the characteristics of feed robot but operating at a semi-autonomous level of autonomy

EXAMPLE Hanging MFU.

3.2.2

feed robot

actuated programmable mechanism operating autonomously

3.3

operator

local or remote positioned designated person who is responsible for the movement and operation of the RFS

3.4

feed storage area

designated area where one or more different *feed storage devices* (3.5) are located and/or where feedstuffs are stocked in bulk

3.5

feed storage device

stationary device for intermediate storage and processing of feedstuffs (e.g. feed bunker) as part of an *RFS* (3.1)

3.6

loading

transferring feedstuffs into the *MFU* (3.2)

3.7

loading area

designated area where the *loading* (3.6) is performed

3.8

service mode

mode of machine operation in which service is performed

Note 1 to entry: See ISO 4254-1:2013, 3.2 for the definition of service.

3.9

common zone

designated area open to all people which includes the autonomous operating zone of the RFS

3.10

caution zone

designated area part of a *common zone* (3.1) where there is an increased safety risk, e.g. due to inadequate clearance or where a *loading* (3.6) takes place

3.11

restricted zone

designated and physically separated area, which contains hazardous autonomous functions of the RFS in which only authorized persons are permitted to enter

3.12

non-contact protective system

non-contact protective equipment fitted to the MFU, having one or more detection zones that generates a signal prior to physical contact

Note 1 to entry: Non-contact protective equipment can include different types of technologies such as optical, laser, radar, etc.

3.13

MFU with ride-on capability

self-propelled MFU equipped with controls for manual operation by an onboard operator

3.14

continuous fixed structure

fixed objects belonging to the farm buildings restricting the path of the MFU over a long distance (e.g. walls, fences)

Note 1 to entry: Continuous fixed structures can also be boundaries for the path of the MFU.

3.15

non-continuous fixed structure

fixed objects belonging to the farm buildings restricting the path of the MFU over a limited distance (e.g. pillars, trusses, doorways)

4 Safety requirements and/or protective measures

4.1 General

The manufacturer's risk assessment shall account for the specific type of livestock for which the RFS is intended to be used.

When the RFS is intended to be used for other kind of animals other than livestock, the manufacturer shall perform an additional risk assessment for potential risks caused to this kind of animals.

Agricultural machinery (self-propelled ride-on, mounted, semi-mounted and trailed) shall conform with the relevant portions of machine-specific safety standards [e.g. ISO 4254 (all relevant parts), EN 703:2021] and this clause for protective or risk reduction measures of relevant significant hazards.

NOTE Portions of relevant machine-specific safety standards will not be applicable due to the potential unique characteristics of agricultural machinery semi-autonomous and autonomous functions. For example, portions of a safety standard that address requirements for a local operator station will not be applicable to a machine that does not have a local operator station.

RFS shall conform with the safety requirements and/or protective/risk reduction measures of this clause. In addition, the RFS shall be designed according to the principles of ISO 12100:2010 for relevant but not significant hazards, which are not dealt with by this document. Significant hazards resulting of interaction of the RFS with existing equipment on the farm (e.g. tower silo) is dealt with in [Clause 5](#).

This applies especially for the interaction between the particular functions and parts of the RFS.

Unless otherwise specified in this document, the RFS shall conform to the requirements of ISO 13857:2019, Tables 1, 2, 3, 4 and 6 as appropriate.

Irregularities, loss or return of power supply or failure of the control system shall not lead to hazardous situations.

Provisions shall be taken to ensure continued safe operation of critical function(s) (e.g. opening of feed grabber, dropping feed, MFU rolling down from slope) resulting from failure of the power supply.

Hydraulic systems, if applicable, shall be in accordance with ISO 4254-1:2013, 4.13.

Mechanical movements, whether intended or unintended (e.g. effects from acceleration/deacceleration or lifting/holding of masses) shall not result in a situation hazardous to persons.

Performance Levels for safety related parts of control systems, shall be determined in accordance with ISO 25119-1:2018, ISO 25119-1:2018/Amd 1:2020 and ISO 25119-2:2019 and ISO 25119-3:2018, ISO 25119-3:2018/Amd 1:2020 and ISO 25119-4:2018, ISO 25119-4:2018/Amd 1:2020, or ISO 13849-1:2023 and ISO 13849-2:2012. See [Annex C](#).

RFS shall comply with the requirements of electromagnetic compatibility as specified in ISO 4254-1:2013, 4.18 or shall comply with IEC 61000-6-2:2016 for immunity and IEC 61000-6-4:2018 for emission in industrial environments.

Laser product, if used, shall be in accordance with IEC 60825-1:2014. Laser products shall be mounted such that they do not create any risk for the operator.

Visibility of driving positions of MFU with ride-on capability shall be in accordance with EN 703:2021, 4.3.

Exposed parts of RFS shall not have sharp corners, edges, rough surfaces, etc. which can cause injury to persons or farm animals who can come into contact with the RFS.

4.2 Storage of feed

4.2.1 General

Access to potentially hazardous moving parts inside the feed storage area or feed storage device(s) shall be prevented.

This requirement is deemed to be fulfilled if the measures given in [4.2.2](#) and [4.2.3](#) are applied.

4.2.2 Feed storage devices

The height of the wall(s) of the feed storage device shall have a minimum height of 1,50 m, in accordance with ISO 13857:2019.

All walls shall be designed such that easy over climbing without additional means is prevented (e.g. by smooth surface, no horizontal structures).

Safety distances to the hazardous parts shall be in accordance with ISO 13857:2019, Tables 2 and 4.

If movable guards are used, they shall be of interlocking guard type or of interlocking guard with guard locking type according to ISO 14119:2024. Opening of interlocking guards of the feed storage device(s) where used shall automatically stop all the hazardous functions. It shall only be possible to re-enter the active state by an operator outside the feed storage device, at a safety distance in accordance with ISO 13857:2019, Tables 2 and 4.

A means of easily enabling climbing out of the feed storage shall be provided.

To enable the operator to check the feedstuff levels, when the upper edge of the feed storage device is at least 1,60 m from the ground, means shall be provided. These means shall be:

- an opening located at a convenient height and in accordance with ISO 13857:2019, Tables 1, 2, 3, 4 and 6; or
- a boarding means, the distance between the upper step and the upper edge of the compartment being not less than 1,50 m but not more than 1,60 m. See [Figure 1](#); or
- observation means to allow indirect visibility from the operator position (e.g. by mirrors or a closed circuit camera system); or
- level indicators.