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## Stroji za predelavo gume in plastike - Kalandri - Varnostne zahteve

Plastics and rubber machines - Calenders - Safety requirements

Kunststoff- und Gummimaschinen - Kalander - Sicherheitsanforderungen

Machines pour le caoutchouc et les matières plastiques - Calandres - Prescriptions de sécurité

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**Plastics and rubber machines - Calenders - Safety requirements**

Machines pour les matières plastiques et le caoutchouc  
- Calandres - Prescriptions de sécurité

Kunststoff- und Gummimaschinen - Kalander -  
Sicherheitsanforderungen

This European Standard was approved by CEN on 5 August 2019.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION  
COMITÉ EUROPÉEN DE NORMALISATION  
EUROPÄISCHES KOMITEE FÜR NORMUNG

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## European foreword

This document (EN 12301:2019) has been prepared by Technical Committee CEN/TC 145 “Plastics and rubber machines”, the secretariat of which is held by UNI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2020 and conflicting national standards shall be withdrawn at the latest by June 2021.

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

This document supersedes EN 12301:2000+A1:2008.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

The main changes with respect to the previous edition EN 12301:2000+A1:2008 are as follows:

- the Scope is extended to cover also two-roll calenders forming an integral unit with an extruder (roller head) and two or three-roll polishing, laminating or embossing units installed downstream of extruders in film processing lines;
- the structure is modified;
- the list of significant hazards is moved to an informative annex;
- technical developments in safeguards are taken into account;
- requirements for braking system and roll separation are updated;
- revised type-A and type-B standards are taken into account;
- the performance levels of safety related parts of control systems are specified in accordance with EN ISO 13849-1:2015;
- a full noise test code is provided in a normative annex.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

## Introduction

This document is a type C standard as stated in EN 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).

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 or hazardous events are covered are indicated in the Scope of this document.

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

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## 1 Scope

This document specifies safety requirements relating to the design and construction of calenders (see 3.1.1) intended for the calendaring, polishing, laminating or embossing of rubber or plastics.

This document concerns the calender alone, including the following integrated components: cutting device, stock guides, feeding device and secondary roller.

Annex C shows examples of various types of calenders and Annex D shows examples of calendaring processes.

This document deals with all significant hazards, hazardous situations or hazardous events relevant to the design and construction of calenders, when the machines are used as intended and under the conditions of misuse which are reasonably foreseeable by the manufacturer during all the phases of the life of the machine as described in EN ISO 12100:2010, 5.4 (see Annex B).

This document does not deal with:

- hazards generated by the processing of explosive materials, or materials which give rise to an explosive atmosphere;
- hazards due to laser or ionizing radiation;
- hazards generated if the calender is installed in an explosive atmosphere.

Two roll mills are covered by EN 1417.

This document is not applicable to calenders 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.

CLC/TS 61496-3:2008, *Safety of machinery - Electro-sensitive protective equipment - Part 3: Particular requirements for Active Opto-electronic Protective Devices responsive to Diffuse Reflection (AOPDDR)*

EN 349:1993+A1:2008, *Safety of machinery - Minimum gaps to avoid crushing of parts of the human body*

EN 614-1:2006+A1:2009, *Safety of machinery - Ergonomic design principles - Part 1: Terminology and general principles*

EN 619:2002+A1:2010, *Continuous handling equipment and systems — Safety and EMC requirements for equipment for mechanical handling of unit loads*

EN 12198-1:2000+A1:2008, *Safety of machinery - Assessment and reduction of risks arising from radiation emitted by machinery - Part 1: General principles*

EN 60204-1:2018, *Safety of machinery - Electrical equipment of machines - Part 1: General requirements (IEC 60204-1:2016, modified)*

EN 60947-5-8:2006, *Low-voltage switchgear and controlgear - Part 5-8: Control circuit devices and switching elements - Three-position enabling switches (IEC 60947-5-8:2006)*

EN 61000-6-2:2005, *Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments (IEC 61000-6-2:2005)*

EN 61000-6-4:2007, *Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments (IEC 61000-6-4:2006)*

**EN 12301:2019 (E)**

EN 61310-1:2008, *Safety of machinery - Indication, marking and actuation - Part 1: Requirements for visual, acoustic and tactile signals (IEC 61310-1:2007)*

EN 61496-1:2013, *Safety of machinery - Electro-sensitive protective equipment - Part 1: General requirements and tests (IEC 61496-1:2012)*

EN ISO 3744:2010, *Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Engineering methods for an essentially free field over a reflecting plane (ISO 3744:2010)*

EN ISO 3746:2010, *Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Survey method using an enveloping measurement surface over a reflecting plane (ISO 3746:2010)*

EN ISO 4413:2010, *Hydraulic fluid power - General rules and safety requirements for systems and their components (ISO 4413:2010)*

EN ISO 4414:2010, *Pneumatic fluid power - General rules and safety requirements for systems and their components (ISO 4414:2010)*

EN ISO 4871:2009, *Acoustics - Declaration and verification of noise emission values of machinery and equipment (ISO 4871:1996)*

EN ISO 7731:2008, *Ergonomics - Danger signals for public and work areas - Auditory danger signals (ISO 7731:2003)*

EN ISO 9614-2:1996, *Acoustics - Determination of sound power levels of noise sources using sound intensity - Part 2: Measurement by scanning (ISO 9614-2:1996)*

EN ISO 11201:2010, *Acoustics - Noise emitted by machinery and equipment - Determination of emission sound pressure levels at a work station and at other specified positions in an essentially free field over a reflecting plane with negligible environmental corrections (ISO 11201:2010)*

EN ISO 11202:2010, *Acoustics - Noise emitted by machinery and equipment - Determination of emission sound pressure levels at a work station and at other specified positions applying approximate environmental corrections (ISO 11202:2010)*

EN ISO 11204:2010, *Acoustics - Noise emitted by machinery and equipment - Determination of emission sound pressure levels at a work station and at other specified positions applying accurate environmental corrections (ISO 11204:2010)*

EN ISO 11688-1:2009, *Acoustics - Recommended practice for the design of low-noise machinery and equipment - Part 1: Planning (ISO/TR 11688-1:1995)*

EN ISO 12100:2010, *Safety of machinery - General principles for design - Risk assessment and risk reduction (ISO 12100:2010)*

EN ISO 13732-1:2008, *Ergonomics of the thermal environment - Methods for the assessment of human responses to contact with surfaces - Part 1: Hot surfaces (ISO 13732-1:2006)*

EN ISO 13849-1:2015, *Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design (ISO 13849-1:2015)*

EN ISO 13850:2015, *Safety of machinery - Emergency stop function - Principles for design (ISO 13850:2015)*

EN ISO 13851:2019, *Safety of machinery - Two-hand control devices - Principles for design and selection (ISO 13851:2019)*



EN ISO 13855:2010, *Safety of machinery - Positioning of safeguards with respect to the approach speeds of parts of the human body (ISO 13855:2010)*

EN ISO 13856-1:2013, *Safety of machinery - Pressure-sensitive protective devices - Part 1: General principles for design and testing of pressure-sensitive mats and pressure-sensitive floors (ISO 13856-1:2013)*

EN ISO 13857:2008, *Safety of machinery - Safety distances to prevent hazard zones being reached by upper and lower limbs (ISO 13857:2008)*

EN ISO 14118:2018, *Safety of machinery - Prevention of unexpected start-up (ISO 14118:2017)*

EN ISO 14119:2013, *Safety of machinery - Interlocking devices associated with guards - Principles for design and selection (ISO 14119:2013)*

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

EN ISO 14122-1:2016, *Safety of machinery - Permanent means of access to machinery - Part 1: Choice of fixed means and general requirements of access (ISO 14122-1:2016)*

EN ISO 14122-2:2016, *Safety of machinery - Permanent means of access to machinery - Part 2: Working platforms and walkways (ISO 14122-2:2016)*

EN ISO 14122-3:2016, *Safety of machinery - Permanent means of access to machinery - Part 3: Stairs, stepladders and guard-rails (ISO 14122-3:2016)*

EN ISO 14122-4:2016, *Safety of machinery - Permanent means of access to machinery - Part 4: Fixed ladders (ISO 14122-4:2016)*

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

### 3 Terms, definitions and symbols

#### 3.1 Terms and definitions

For the purposes of this document, the terms and the definitions given in EN ISO 12100:2010 and the following apply.

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

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

##### 3.1.1 calender

machine for processing rubber, plastics, solutions or dispersions by continuous drawing between two or more rolls, which are supported at both ends by a frame

Note 1 to entry: The processing operations may be, for example:

- continuous calendaring of sheets or profiles of rubber or plastics;
- application of one or more sheet(s) or layer(s) onto a support material;
- laminating of two or more sheets of rubber or plastics under pressure or by using heat or adhesive;
- embossing or polishing of plastics (for example smoothing roll stack).

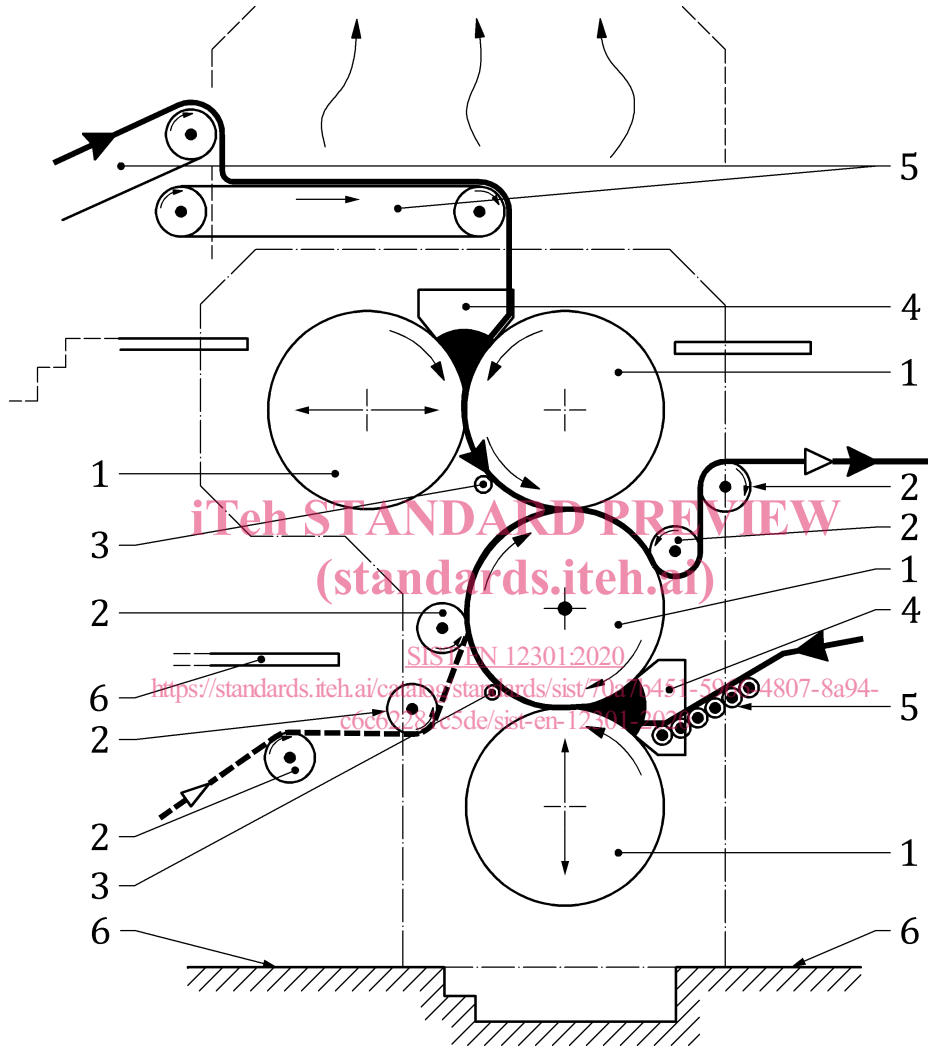
## EN 12301:2019 (E)

The calender can be equipped with power operated wheels for the horizontal movement of the complete machine, e.g. for engaging/disengaging it from an extruder head during setting-up operations.

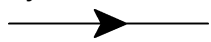
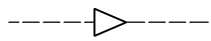
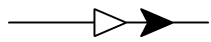
Note 2 to entry: Figure 1 shows a typical calendaring sequence and the positions of most of the components and zones defined hereafter. Figure 2 shows a typical 3-roll stack supplied by an extruder.

Note 3 to entry: Annex C shows examples of various types of calendars.

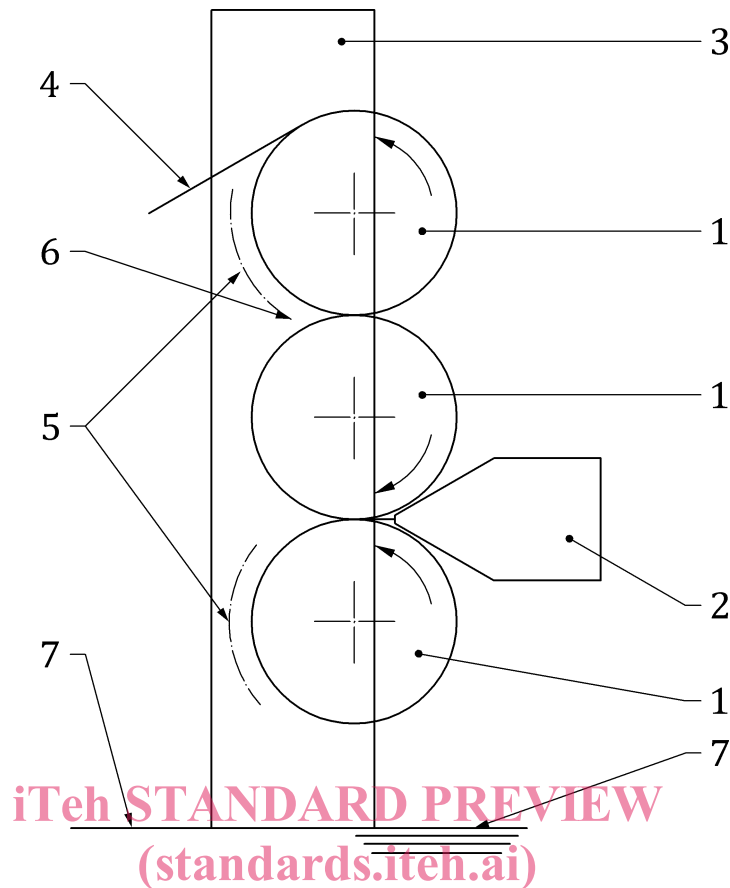
Note 4 to entry: Annex D shows examples of various calendaring processes.



## Key

	rubber/plastic circuits
	cord/fabric circuit
	calendered product circuit
1	calender rolls
2	secondary rollers
3	cutting devices
4	stock guides
5	feeding devices
6	working zones

**Figure 1 — Example of a 4-roll calender showing the materials circuit for bilateral coating of (textile or metallic) fabric or cords**

**Key**

- |   |               |   |               |
|---|---------------|---|---------------|
| 1 | calender roll | 5 | cleaning zone |
| 2 | extruder head | 6 | crushing zone |
| 3 | frame         | 7 | working zone  |
| 4 | film          |   |               |

**Figure 2 — Example of a 3-roll stack supplied by an extruder**

**3.1.2****calender roll**

roll which is positioned in relation to other calender rolls in order to process the material

Note 1 to entry: The roll can be counterbored or drilled to enable its temperature to be controlled by fluid circulation.

**3.1.3****secondary roller**

roller, which is used to support the calendaring process

Note 1 to entry: It can be driven and temperature regulated.

Note 2 to entry: Examples of secondary rollers are: pressure rollers, embossing rollers, filament guide rollers, tension rollers, stripper rollers, crease removing rollers, take-off rollers.

**3.1.4****cutting device**

equipment for trimming the edges of the sheet to one or more specified widths

EXAMPLE Fixed knives (wires or blades), rotating knives (cutting discs).

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**3.1.5****stock guides**

devices located on either side of the feed zone which determine the width of the sheet to be calendered and retain the stock thus preventing it from extending beyond the normal working area

**3.1.6****feeding device**

equipment for feeding and distributing the stock in the feed zone

EXAMPLE Table, grid, chute, conveyor, reciprocating feed conveyor.

**3.1.7****stopping angle**

angle through which the calender rolls rotate from the stop signal triggered by a protective device until the calender rolls have come to rest

**3.1.8****feed zone**

zone in which stock (rubber or plastic etc.) and/or material (cords, web, fabric etc.) is fed into the calender

**3.1.9****working zone**

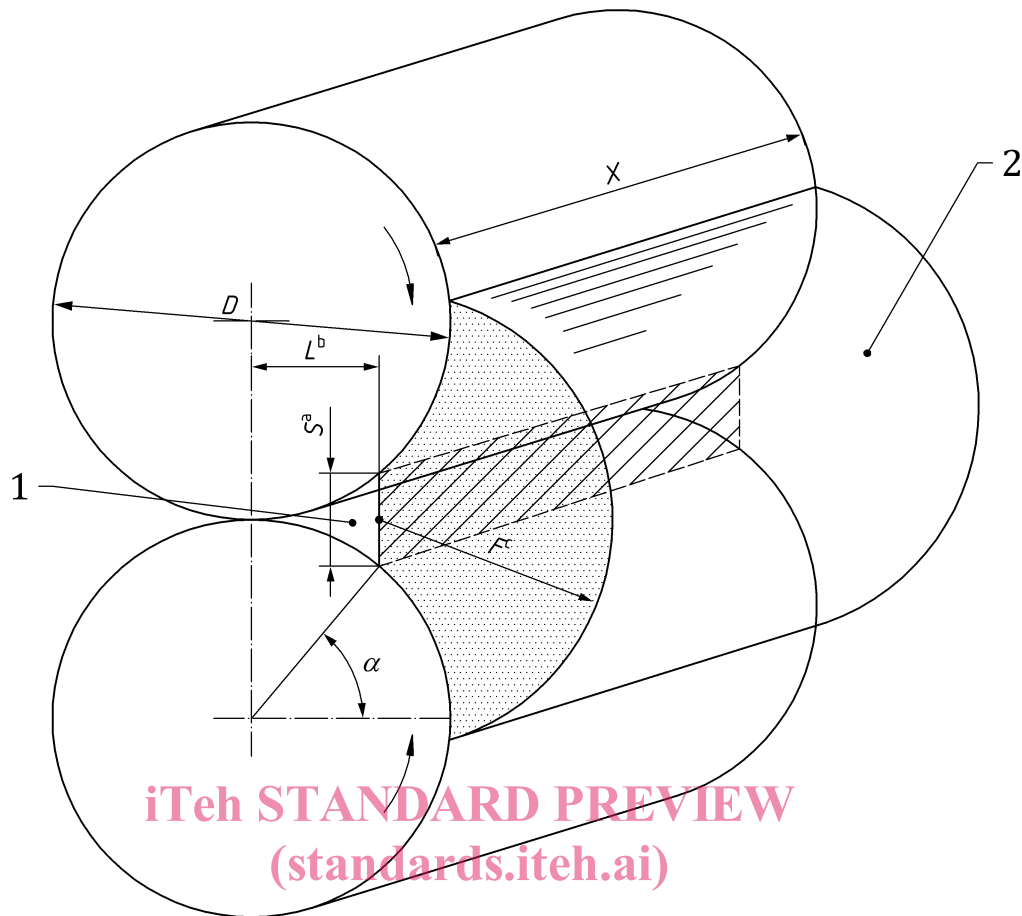
area around the calender or standing zone where the operators carry out their normal duties

**3.1.10****crushing zone**

zone existing between two calender rolls close to each other rotating in opposite directions towards the nip

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Note 1 to entry: See Figure 3.

**Key**

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- 1 crushing zone <https://standards.iteh.ai/catalog/standards/sist/70a7b451-5966-4807-8a94-c6c62281c5de/sist-en-12301-2020>
- 2 danger zone
- S* line dimensioned at the entrance to the crushing zone
- X* length of calender roll
- L* depth of the crushing zone, expressed in millimetres
- D* diameter of the calender rolls, expressed in millimetres
- $\alpha$  stopping angle, expressed in radians
- F* radius equivalent to the length of the arcs of circle on the calender rolls corresponding with the specified stopping angle, expressed in millimetres
- <sup>a</sup> *S* needs to be taken as 12 mm when the rolls are theoretically in contact, irrespective of the roll diameter.
- <sup>b</sup>  $L = \sqrt{6 \times D}$ ; where the roll diameters are different *D* shall be taken as the larger diameter
- <sup>c</sup>  $F = \frac{D}{2} \alpha$

NOTE 1 The danger zone is the volume at the inrunning side of the rolls circumscribed by the length *X* of the rolls and the shaded cross-section. This section is delimited by:

- the line dimensioned *S* at the entrance to the crushing zone (see 3.1.10);
- the two arcs of circle on the calender rolls corresponding with the specified stopping angle  $\alpha$  (see 3.1.7);
- the arc of a circle whose centre is the middle of the line dimensioned *S* and whose radius *F* is equivalent to the length of the arcs of circle on the calender rolls corresponding with the specified stopping angle  $\alpha$ .

NOTE 2 An example for the calculation of *L* is given in Annex E; *L* remains constant irrespective of the nip between the rolls.

**Figure 3 — Crushing and danger zones at the calender rolls**

**EN 12301:2019 (E)****3.1.11****setting**

preparing the machine for production, machine set-up, etc.

**3.1.12****cleaning**

removal of dust, residual material on the rolls, etc.

**3.2 Symbols**

$\alpha$	stopping angle of the calender roll when running with production speed $v_p$
$\alpha_{max}$	maximum stopping angle of the calender roll when running with maximum speed $v_{max}$
$\alpha_r$	reduced stopping angle of the calender roll when running with reduced speed $v_r$
$v_p$	production rotational speed of calender rolls
$v_{max}$	maximum rotational speed of the calender rolls
$v_r$	reduced rotational speed of the calender rolls
$D$	(larger) diameter of the calender rolls
$F$	length of arc $\alpha$ on the calender roll surface
$F_r$	length of arc $\alpha_r$ on the calender roll surface
$S$	height of entrance of the crushing zone
$L$	depth of crushing zone

**4 Safety requirements and/or protective measures****4.1 General**

Calenders shall comply with the safety requirements and/or protective/risk reduction measures of this clause. In addition, the machine shall be designed according to the principles of EN ISO 12100:2010 for relevant but not significant hazards, which are not dealt with by this document (e.g. sharp edges).

The hydraulic equipment and its components shall be designed in accordance with EN ISO 4413:2010.

The pneumatic equipment and its components shall be designed in accordance with EN ISO 4414:2010.

**4.2 Control systems****4.2.1 General**

The safety related parts of the control system shall be designed in accordance with EN ISO 13849-1:2015. The required performance level (PL<sub>r</sub>) for each safety function is specified in the relevant subclauses.

In the case where the calender is provided with a mode selector, it shall be in accordance with EN ISO 12100:2010, 6.2.11.10.

#### 4.2.2 Starting

The start of an operation shall be possible only when all safeguards are in place and functional (see EN 60204-1:2018, 9.2.3.2). The machine shall only be started by actuation of the start device provided for that purpose.

#### 4.2.3 Normal stopping

A normal stop device shall be provided to bring the machine to a complete stop.

The normal stop command shall function as a stop category 0 or 1 in accordance with EN 60204-1:2018, 9.2.2, depending on the used technology.

#### 4.2.4 Emergency stop devices

The emergency stop devices shall comply with EN ISO 13850:2015. For electrical braking, stop category 1 of that standard shall apply. For calenders with simple mechanical braking systems which are not dependent on electrical energy, stop category 0 may be selected. An emergency stop device shall be provided on the control panel of the calender. Other emergency stop actuators shall be installed in the vicinity of and on each side of the working zones.

The actuation of any emergency stop device shall

- cause stopping of the calender rolls in accordance with 4.2.6;
- allow the roll separation or cause automatic roll separation on machines equipped with protective device requiring automatic roll separation (see 4.3.1.3, 4.3.1.4, 4.3.1.5 and 4.3.1.6);
- allow the rescue reverse movement in accordance with 4.2.7;
- cause the stopping of all integrated components according to  $PL_r = c$ ;
- trigger a visual and/or auditory signal, with manual resetting.

See also EN 60204-1:2018, 10.7.

#### 4.2.5 Failure of energy supply

An interruption or a failure of the power supply shall not result in a loss of safety function and restoration of the energy supply shall not result in the automatic restarting of the machine (see EN ISO 12100:2010, 6.2.11.4 and 6.2.11.5).

Failure of the energy supply which causes opening of a contactor of one of the roll drive motors shall also cause stopping of the rolls as specified in 4.2.6.

The calender shall also be equipped with a device to enable roll separation to be achieved even in the event of energy failure (see 6.2.3 m)).

#### 4.2.6 Braking system

In case where the calender rolls can stop without material from maximum speed within a maximum stopping angle  $\alpha_{\max}$  of  $120^\circ$  there are no specific requirements for braking system.

In the case where inrunning nips are protected by fixed guards there are no specific requirements for braking system and stopping angle (see 4.3.1.2).

In the case where inrunning nips are protected by an interlocking guard with guard locking function in accordance to  $PL_r = d$ , there are no specific requirements for braking system and stopping angle.