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Plastics and rubber machines — Tyre curing machines — Safety requirements

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A list of organizations represented on this committee can be obtained on request to its secretary.

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Machines pour les matières plastiques et le caoutchouc -
Machines à vulcaniser les pneumatiques - Prescriptions de
sécurité

Kunststoff- und Gummimaschinen -
Reifenvulkanisiermaschinen - Sicherheitsanforderungen

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Foreword

This document (EN 16474:2015) 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of an identical text or by endorsement, at the latest by October 2015, and conflicting national standards shall be withdrawn at the latest by October 2015.

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For relationship with EU Directive 2006/42/EC, see informative Annex ZA, which is an integral part of this document.

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Introduction

This European Standard is a type C standard as stated in EN ISO 12100.

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

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 in accordance with the provisions of this type C standard.

1 Scope

This European Standard applies to tyre curing machines having the following configuration.

- crossing flow tyre curing machines, with two cavities with:
 - common curing cycle and common safeguarding; or
 - independent curing cycles and common safeguarding; or
 - independent curing cycles and independent safeguarding;
- tyre curing machines with one cavity;
- tyre curing machines with automatic rear feeding and discharge.

The safety requirements and/or protective measures specified in this European Standard apply to tyre curing machines for passenger vehicle tyres and truck tyres.

This European Standard does not deal with:

- feeding system and discharge system;
- tyre curing machines with manual loading of the green tyre into the mould and manual unloading of the cured tyre from the mould;
- ancillary equipment which is not an integral part of the tyre curing machine, e.g. conveying equipment;
- exhaust systems.

This European Standard deals with all significant hazards, hazardous situations and events relevant to tyre curing machines, when they are used as intended and under conditions of misuse which are reasonably foreseeable by the manufacturer (see Clause 4).

It does not deal with hazards associated with falling of parts of the container or mould.

Some tyre curing machines include pressure vessels, which fall under Directive 97/23/EC [1]; this European standard is not intended to support the Directive 97/23/EC.

This European Standard is not applicable to tyre curing machines which are manufactured before the date of its publication as an EN.

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.

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

EN 953:1997+A1:2009, *Safety of machinery - Guards - General requirements for the design and construction of fixed and movable guards*

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

EN 60204-1:2006, *Safety of machinery - Electrical equipment of machines - Part 1: General requirements (IEC 60204-1:2005)*

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

EN 61496-2:2013, *Safety of machinery - Electro-sensitive protective equipment - Part 2: Particular requirements for equipment using active opto-electronic protective devices (AOPDs) (IEC 61496-2:2013)*

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 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 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 13849-1:2008, *Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design (ISO 13849-1:2006)*

EN ISO 13850:2008, *Safety of machinery - Emergency stop - Principles for design (ISO 13850:2006)*

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

EN 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 13856-3:2013)*

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 14122-2:2001, *Safety of machinery - Permanent means of access to machinery - Part 2: Working platforms and walkways (ISO 14122-2:2001)*

EN ISO 14122-2:2001/A1:2010, *Safety of machinery - Permanent means of access to machinery - Part 2: Working platforms and walkways - Amendment 1 (ISO 14122-2:2001/Amd 1:2010)*

EN ISO 14122-3:2001, *Safety of machinery - Permanent means of access to machinery - Part 3: Stairs, stepladders and guard-rails (ISO 14122-3:2001)*

EN ISO 14122-3:2001/A1:2010, *Safety of machinery - Permanent means of access to machinery - Part 3: Stairs, stepladders and guard-rails - Amendment 1 (ISO 14122-3:2001/Amd 1:2010)*

EN ISO 14122-4:2004, *Safety of machinery - Permanent means of access to machinery - Part 4: Fixed ladders (ISO 14122-4:2004)*

EN ISO 14122-4:2004/A1:2010, *Safety of machinery - Permanent means of access to machinery - Part 4: Fixed ladders - Amendment 1 (ISO 14122-4:2004/Amd 1:2010)*

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) (IEC 61496-3:2008)*

ISO 7010:2011, *Graphical symbols — Safety colours and safety signs — Registered safety signs*

3 Terms and definitions

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

3.1

tyre curing machine

machine used for vulcanisation of tyres usually comprising fixed and movable parts that can be locked together, inside which the green tyre assumes its final shape and characteristics by the use of pressure and heating

Note 1 to entry See Figure 1 and Figure 2.

3.2

crossing flow

machine type in which green tyres are fed and loaded from the front and cured tyres are unloaded and discharged from the rear

3.3

cavity

part of the machine in which the container and/or the mould and the bladder are installed

3.4

green tyre

assembly of rubber parts intended to be cured

3.5

cured tyre

tyre in its final form after vulcanisation

3.6

bladder

inflatable rubber component used to push the green tyre into contact with the mould while being inflated by the curing media

Note 1 to entry: The bladder is connected to the machine by means of the top ring and bottom ring.

3.7

bottom ring

assembly of the bottom bladder clamping plate

3.8

top ring

assembly of the top bladder clamping plate

3.9

green tyre stand

supporting element for the green tyre before loading

3.10

chuck

device for holding or gripping the green or cured tyre

3.11

movable upper part

part of the machine that is opened for loading the green tyre and unloading the cured tyre and is closed and locked during curing

3.12

heating platen

equipment used to heat sidewalls of the mould by contact

3.13

steam dome

equipment used to heat the complete mould by direct contact with the steam

3.14

container

exchangeable equipment used to receive and heat the segments of the curing mould

Note 1 to entry: The container is fixed to the tyre curing machine by use of screws or automatic fixation device.

3.15

mould

exchangeable equipment used to give the external shape to the cured tyre

3.16

dummy mould

subassembly representative of the mould used in industrial conditions

3.17

mould segment

movable part of the mould

3.18

semi-closed position

position of the movable upper part where the still open segments of the mould in the container touch the lower part of the container thus preventing the risk of projection

3.19

feeding

manual or automatic operation to feed green tyres to the loading device

3.20

loading device

device used to pick up the green tyre and insert it into the tyre curing machine

3.21

curing cycle

period of time in which the curing process is completed, i.e. from full closing, squeezing and locking until the pressure is dropped down

3.22

unloading device

device used to remove the cured tyre from the tyre curing machine

3.23

discharge

manual or automatic operation to remove cured tyres from the unloading device

3.24

take-away conveyor

conveyor that is an integral part of the machine and on which the unloading device deposits the cured tyres for discharge to the rear of the tyre curing machine

3.25

spraying device

static or dynamic nozzle(s) used to treat the mould and/or the bladder with treatment fluid

3.26

distance guard

guard which does not completely enclose a danger zone, but which prevents or reduces access by virtue of its dimensions and its distance from the danger zone, e.g. perimeter fence or tunnel guard

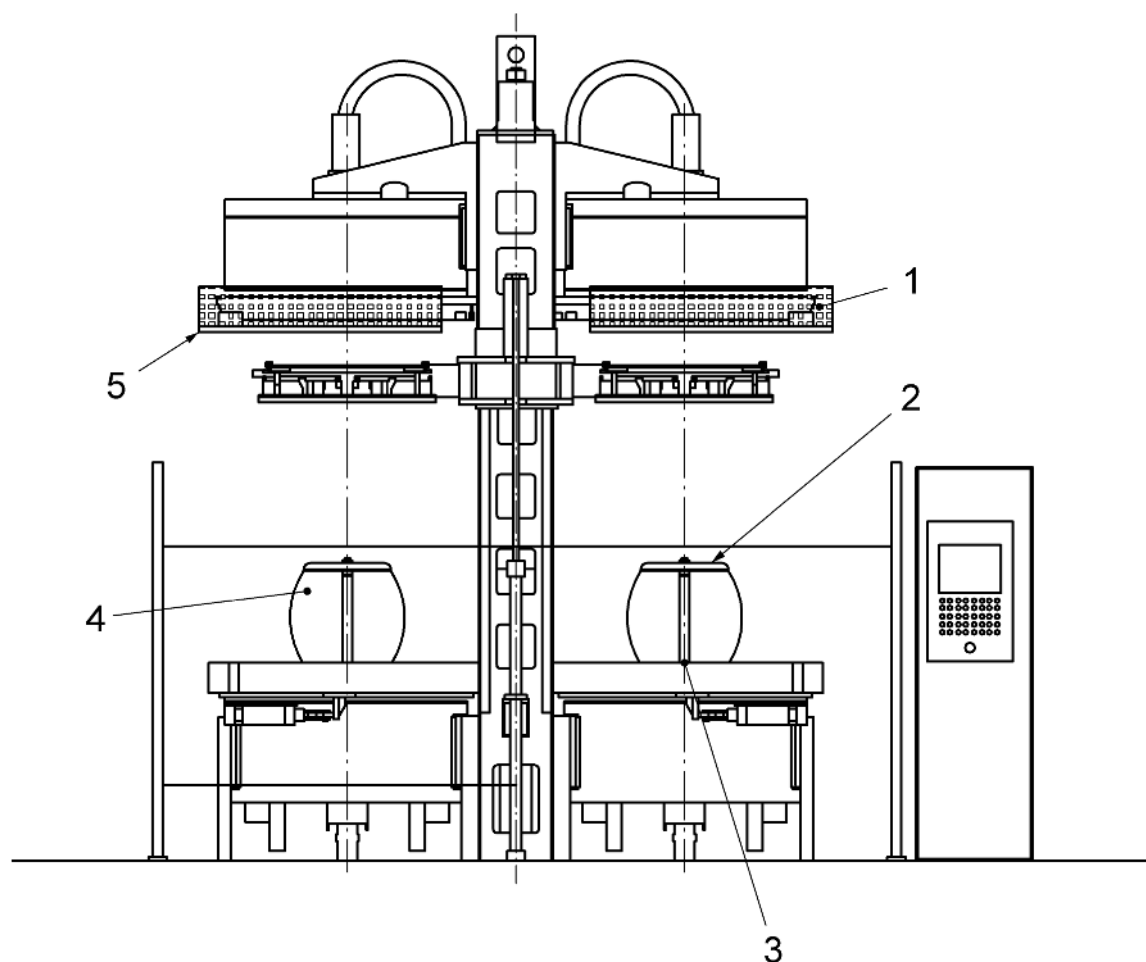
[SOURCE: EN 953:1997+A1:2009, 3.2.2]

3.27

enclosing guard

guard which prevents access to the danger zone from all sides

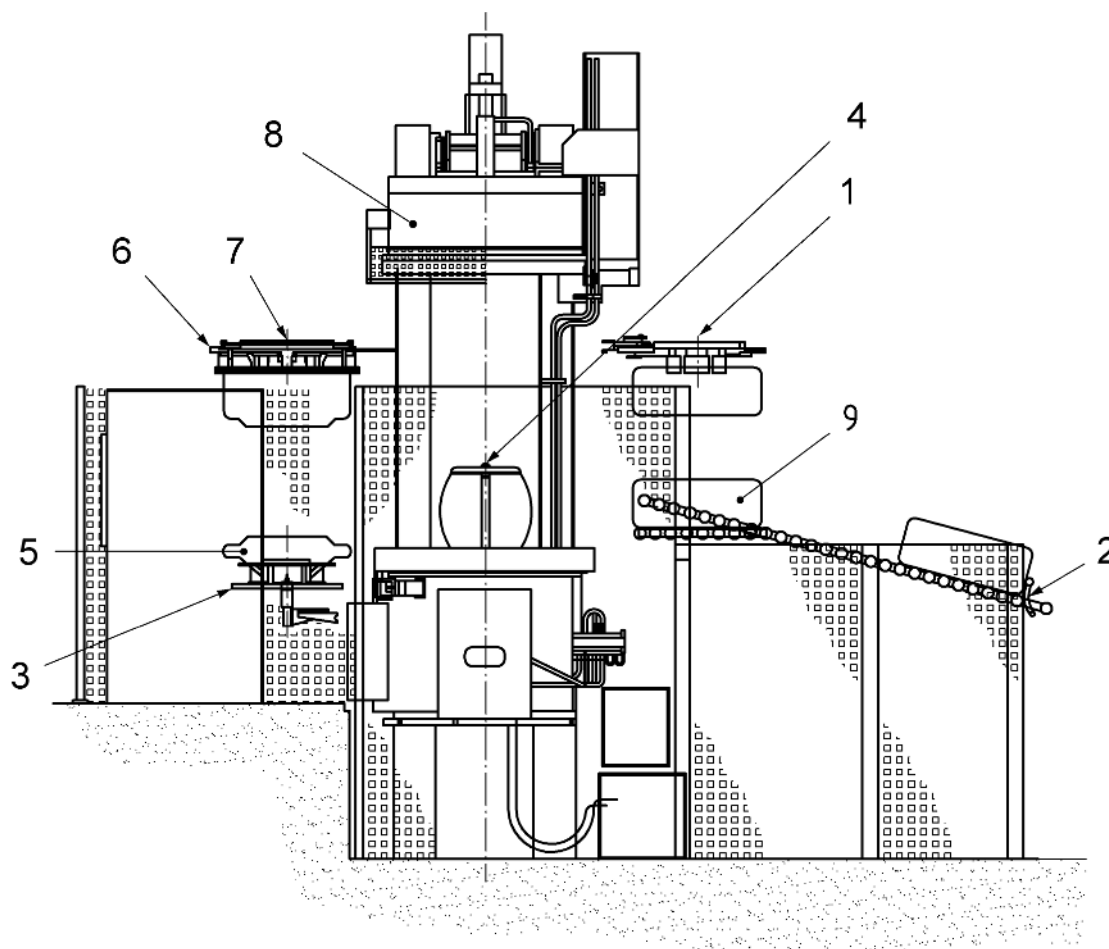
[SOURCE: EN 953:1997+A1:2009, 3.2.1]



Key

- 1 container
- 2 top ring
- 3 bottom ring
- 4 bladder
- 5 heating platen

Figure 1 — Main parts of tyre curing machines (front view)



Key

- 1 unloading device
- 2 take-away conveyor
- 3 green tyre stand
- 4 top ring
- 5 green tyre
- 6 loading device
- 7 chuck
- 8 movable upper part
- 9 cured tyre

Figure 2 — Main parts of tyre curing machines (side view)

4 List of significant hazards

4.1 General

This clause contains all the significant hazards, hazardous situations and events identified by risk assessment as significant for this type of machinery and which require action to eliminate or reduce the risk.

For the location of hazards on crossing flow tyre curing machines, see Figure 3, Figure 4 and Figure 5.

For the location of hazards on tyre curing machines with automatic rear feeding and discharge, see Figure 6, Figure 7 and Figure 8.

The numbering of hazards on Figure 3 to Figure 8 and in 4.3 corresponds to the numbering of hazards in Table 1.

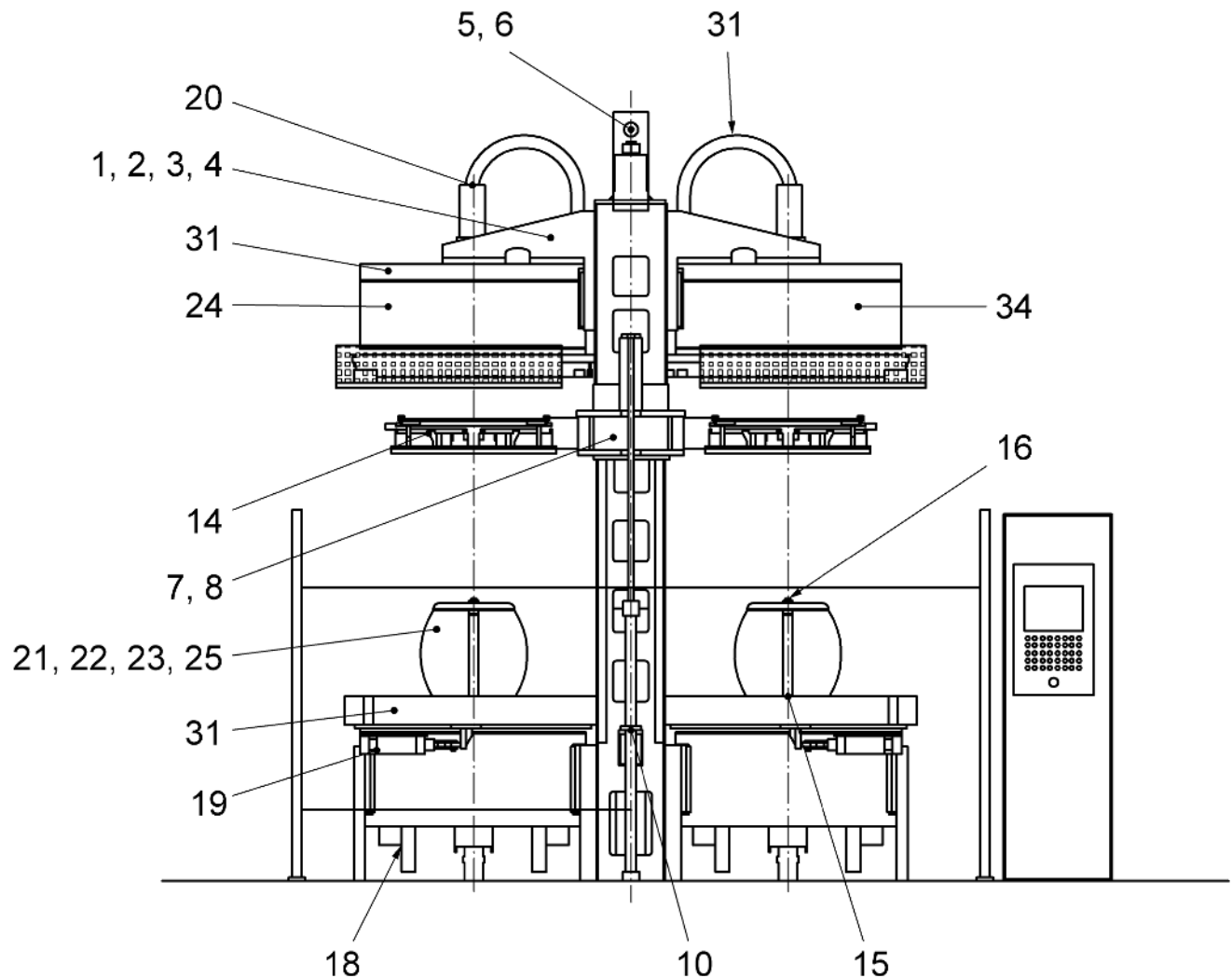


Figure 3 — Location of hazards on crossing flow tyre curing machines (front view)

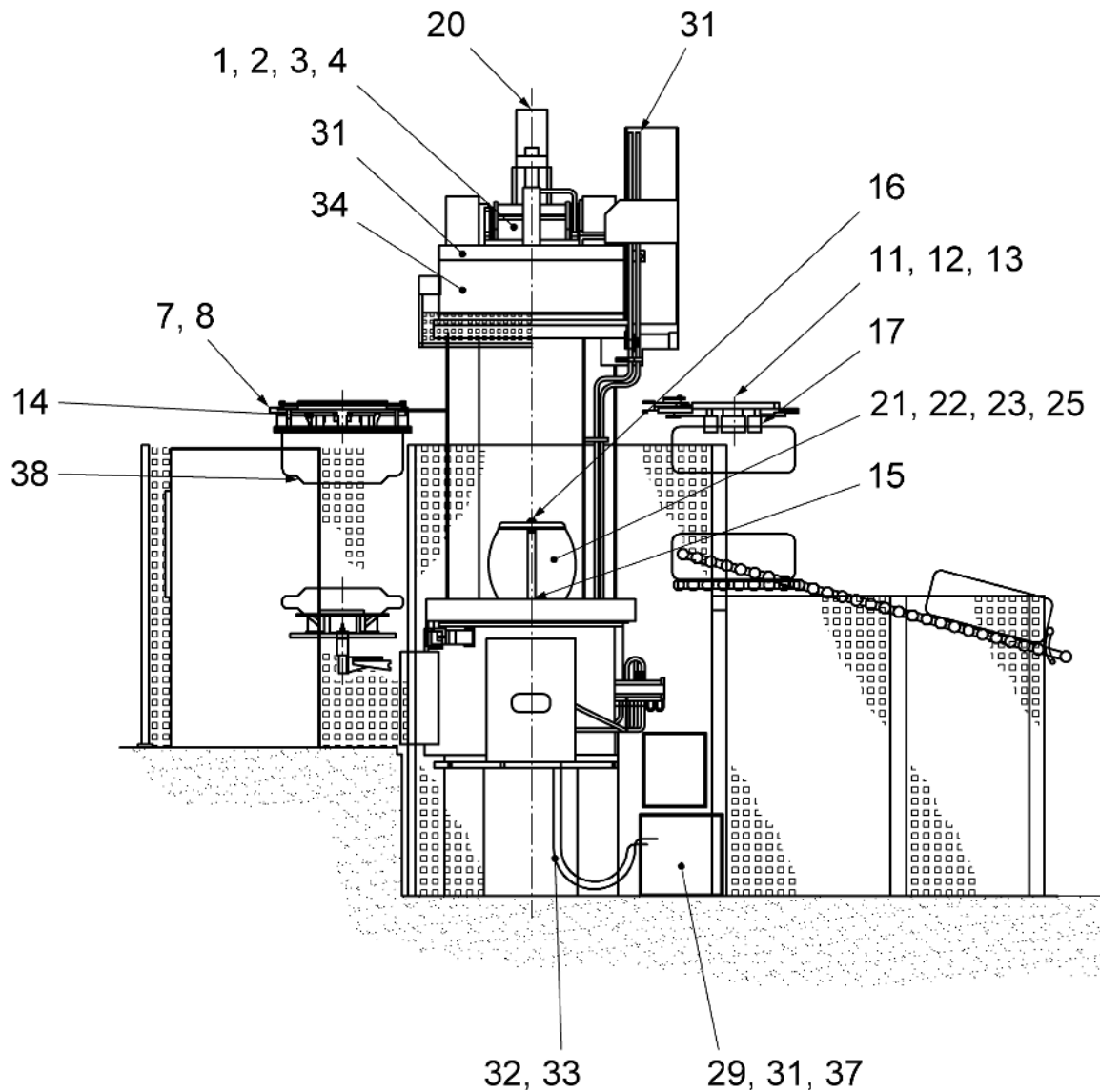


Figure 4 — Location of hazards on crossing flow tyre curing machines (side view)

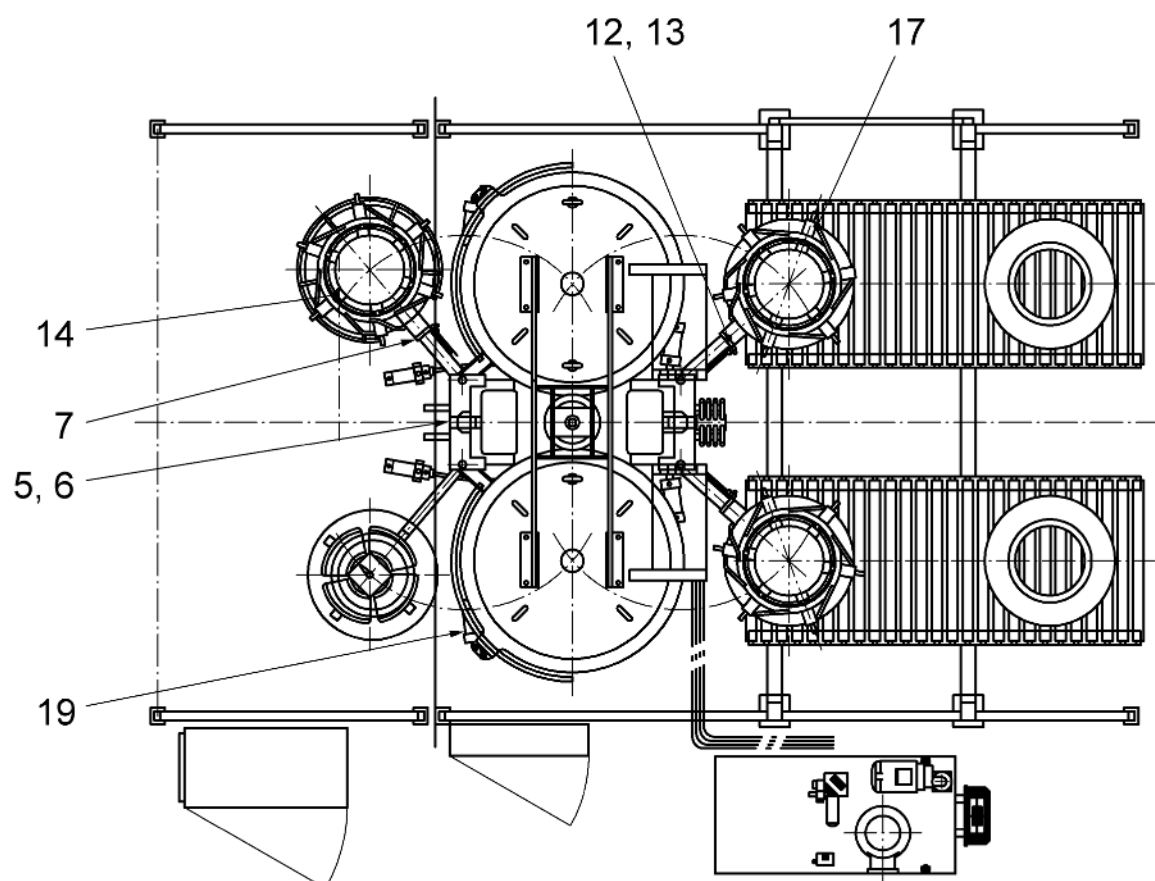


Figure 5 — Location of hazards on crossing flow tyre curing machines (top view)

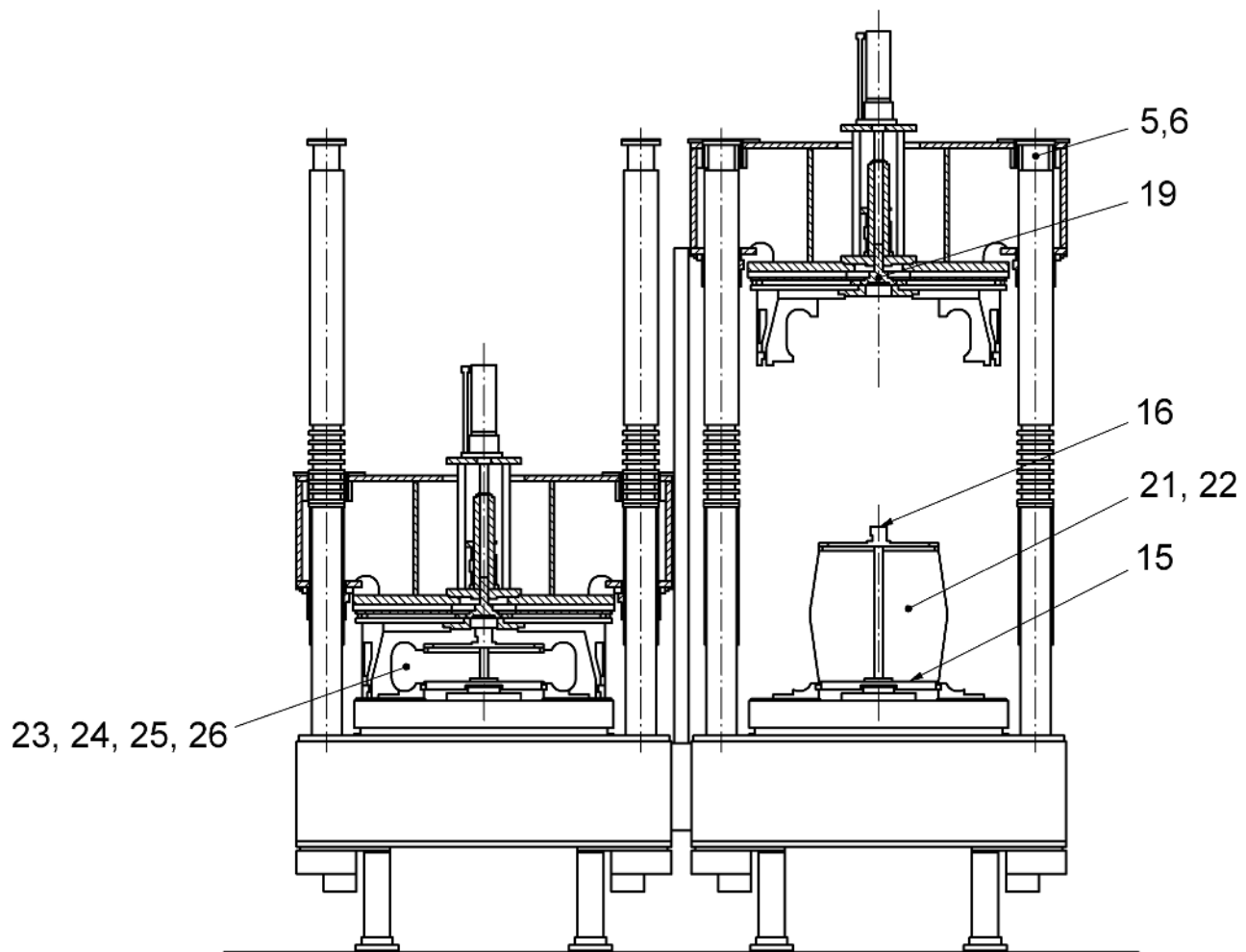


Figure 6 — Location of hazards on tyre curing machines with automatic rear feeding and discharge (front view)

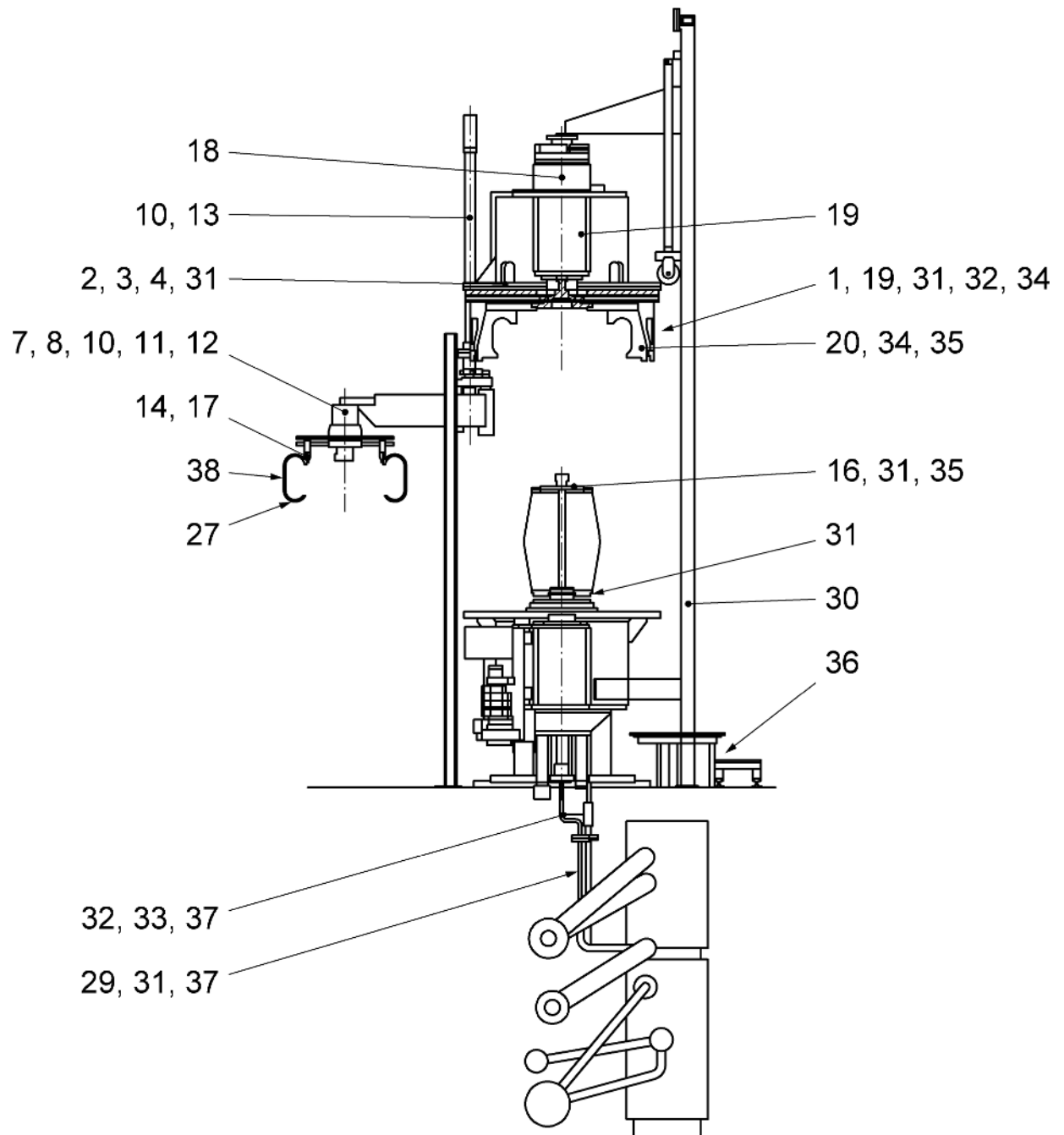


Figure 7 — Location of hazards on tyre curing machines with automatic rear feeding and discharge (side view)

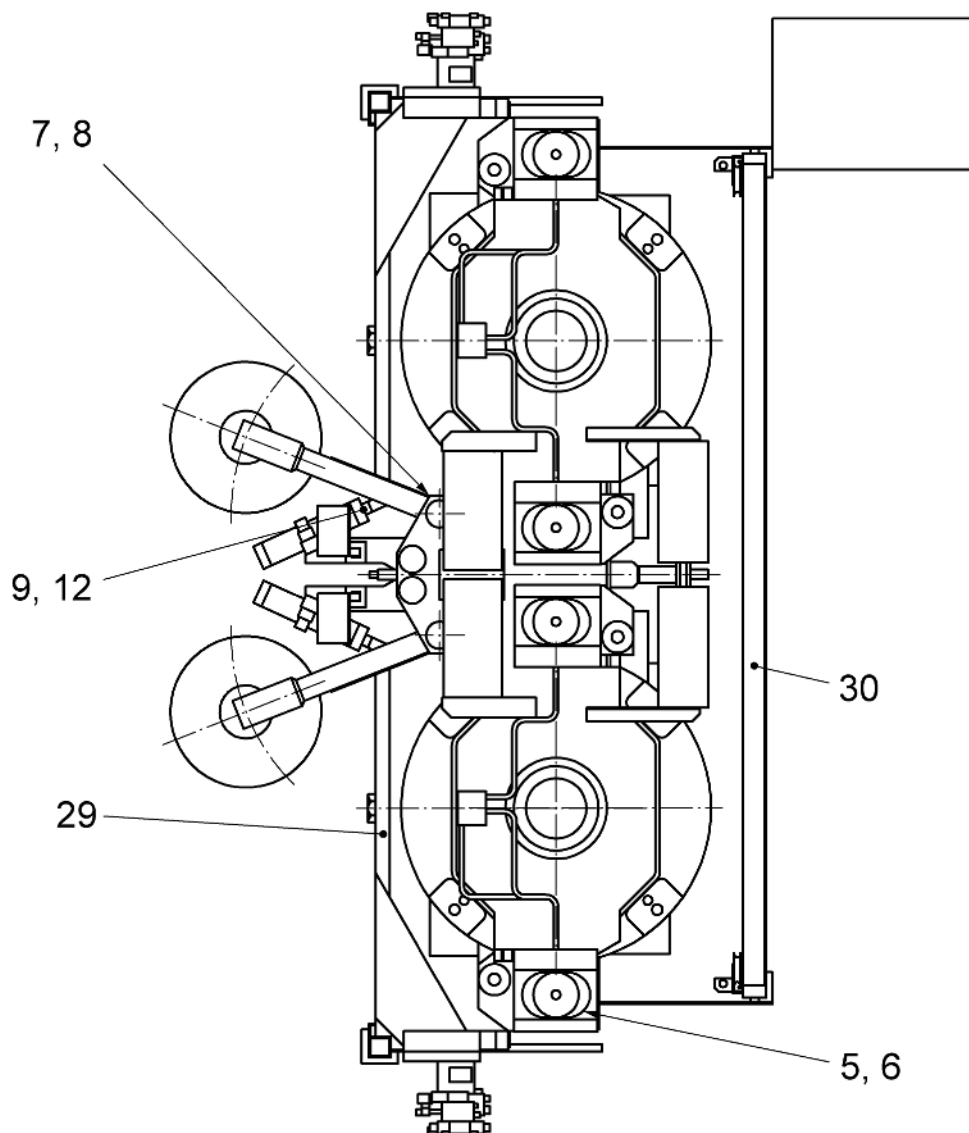


Figure 8 — Location of hazards on tyre curing machines with automatic rear feeding and discharge (top view)

4.2 General hazards

Electric shock or burns due to direct or indirect contact with live conductive parts (see 5.1).

Hazards due to malfunction of the hydraulic or pneumatic systems (see 5.1).

Hazards from high noise levels resulting for example in hearing impairment, tiredness, stress, loss of balance or awareness, interference with speech communications or with the perception of acoustic signals (see 5.4).

Hazards due to neglecting ergonomic principles, e.g. musculoskeletal disorders due to posture, efforts and/or repetitive activity related to manual feeding of green tyres (see 5.1).

4.3 Hazards associated with specific machine parts or areas

The significant hazards associated with specific parts or areas of tyre curing machines are the following:

- 1) Crushing, shearing and/or entanglement due to closing of the movable upper part;
- 2) Crushing, shearing, entanglement and/or impact due to opening of the movable upper part;
- 3) Crushing due to unexpected falling of the movable upper part when it is in the fully open position;
- 4) Crushing due unexpected gravity fall of the movable upper part when it is in any raised position;
- 5) Crushing and/or shearing due to locking of the movable upper part;
- 6) Crushing and/or shearing due to unlocking of the movable upper part;
- 7) Crushing, shearing and/or impact due to downward movement of the loading device and/or green tyre stand;
- 8) Crushing, shearing and/or impact due to upward movement of the loading device and/or green tyre stand;
- 9) Crushing, shearing and/or impact due to rotation of the loading device (chuck type);
- 10) Crushing, shearing and/or impact due to unexpected gravity fall of the loading device when it is in raised position;
- 11) Crushing, shearing and/or impact due to downward movement of the unloading device;
- 12) Crushing, shearing and/or impact due to upward movement of the unloading device, rotation of the chuck type unloading device or swivelling of the fork type unloading device;
- 13) Crushing, shearing and/or impact due to unexpected gravity fall of the unloading device when it is in raised position;
- 14) Cutting, crushing and/or impact due to expansion/collapse of the chuck elements of the loading device;
- 15) Crushing and/or shearing due to downward and upward movement of the bottom ring;
- 16) Crushing and/or shearing due to downward and upward movement of the top ring;
- 17) Cutting, crushing and/or impact due to expansion/collapse of the chuck elements of the unloading device;
- 18) Crushing and/or cutting due to movement to create/release the squeeze force;
- 19) Crushing and/or shearing due to movement of the automatic container locking and unlocking system;
- 20) Crushing, shearing and/or trapping due to closing movement of the mould segments;
- 21) Bursting and/or ejection of materials or steam due to pressure to the bladder when the tyre curing machine is above the semi-closed position;
- 22) Bursting and/or ejection of materials due to pressure to the bladder when the tyre curing machine is below the semi-closed position;
- 23) Bursting and/or ejection of materials due to pressure to the bladder when the tyre curing machine is closed and locked;
- 24) Bursting ejection of materials, impact, injection and/or burns due to high pressure inside the dome before unlocking;

- 25) Bursting, ejection of materials, impact, injection and/or burns due to high pressure inside the bladder before unlocking;
- 26) Bursting, ejection of materials, impact, injection and/or scalds, due to accumulation of hot water under pressure between the bladder and tyre in case of a leakage of the bladder (only for machines using hot water as curing media);
- 27) Scalds due to accumulation of hot water between the bladder and the tyre or mould;
- 28) Inhalation of substances hazardous to health due to release of fumes;
- 29) Asphyxia due to leakage of nitrogen from pipes;
- 30) Impact, crushing and/or cutting due to movement of power operated guards on tyre curing machines with automatic rear feeding and discharge;
- 31) Burns due to hot parts (pipes, mould, heating platens, hoses, valves, etc.);
- 32) Scalds, burns and/or impact due to rupture of flexible hoses or failure of rigid pipes feeding curing media to the tyre curing machine;
- 33) Scalds due to leakage from flexible hoses or rigid pipes feeding curing media to the tyre curing machine;
- 34) Crushing and/or impact due to falling of the upper part of the container;
- 35) Projection of fluid and/or impact due to movement of the spraying jib, if any and/or inhalation of toxic substances released from the spraying device;
- 36) Fall from working positions at height;
- 37) Projection of fluid and/or burns due to residual pressure of curing media inside pipework;
- 38) Impact and/or crushing due to falling of the green tyre from the loading device or cured tyre from the unloading device.

5 Safety requirements and/or protective measures

5.1 General safety requirements and/or protective measures

Machinery shall comply with the safety requirements and/or protective measures of this clause. In addition, the machines 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.

Safety distances for fixed distance guards and machine parts acting as fixed guards shall comply with EN ISO 13857:2008. For the hazard "reaching over protective structures", if not otherwise specified in the relevant subclauses, Table 2 shall be applied for crushing and shearing hazards, otherwise Table 1 may be used. For reaching through openings, Table 3 and Table 4 shall be used.

Guards shall be designed and manufactured in accordance with EN 953:1997+A1:2009. Interlocking devices shall comply with EN ISO 14119:2013. The choice between interlocking guards and interlocking guards with guard locking shall comply with EN ISO 14119:2013, Clause 7 and EN ISO 13855:2010, Clause 9. Interlocking guards may be power operated on tyre curing machines with automatic rear feeding and discharge.

Light curtains shall be in accordance with EN 61496-1:2013 and EN 61496-2:2013.

Scanners shall comply with CLC/TS 61496-3:2008.

Light curtains and interlocking guards without guard locking shall be positioned in accordance with EN ISO 13855:2010.

Opening an interlocking guard or actuating a protective device shall stop any dangerous movement for which the safeguard is installed before the dangerous moving part can be reached but shall not interrupt the curing process when the tyre curing machine is closed and locked.

The safety related parts of the control system shall be designed in accordance with EN ISO 13849-1:2008. The required performance level (PL_r) for each safety function is specified in the relevant subclauses taking into account the risk assessment.

The electrical equipment shall be in accordance with EN 60204-1:2006.

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.

Power operated take-away conveyors shall be in accordance with EN 619:2002+A1:2010.

Ergonomic principles (see EN 1005-3:2002+A1:2008 and EN 1005-4:2005+A1:2008) shall be taken into consideration for the design of green tyre stands in case of manual feeding.

For tyre curing machines which include pressure equipment, the manufacturer shall consider the forces resulting from the pressurization for the calculation of the mechanical strength of machine parts subjected to these forces. See also Table 1, hazards 21 to 25.

5.2 Specific safety requirements and/or protective measures

5.2.1 Specific requirements for operation in production mode

5.2.1.1 Protection against hazards associated with specific machine parts or areas

Safety requirements and/or protective measures for operation in production mode are given in Table 1 for crossing flow tyre curing machines and for tyre curing machines with automatic rear feeding and discharge.

The lines of Table 1 are related to the respective significant hazards listed in 4.3.

In Table 1, the safety requirements and/or protective measures are specified for the front, rear and side positions on the tyre curing machine. Figure 9 and Figure 10 show these positions.