



SLOVENSKI STANDARD

SIST EN 12547:2000

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Centrifuge - Splošne varnostne zahteve

Centrifuges - Common safety requirements

Zentrifugen - Allgemeine Sicherheitsanforderungen

Centrifugeuses - Prescriptions communes de sécurité

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English version

Centrifuges - Common safety requirements

Centrifugeuses - Prescriptions communes de sécurité

Zentrifugen - Allgemeine Sicherheitsanforderungen

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FOREWORD

This European Standard has been prepared by Technical Committee CEN/TC 313 "Centrifuges - Safety requirements", the secretariat of which is held by SIS.

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of an identical text or by endorsement, at the latest by July 1999, and conflicting national standards shall be withdrawn at the latest by July 1999.

This European Standard 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 standard.

Annexes A and C of this European Standard are normative, whereas annexes B, D, E and ZA are informative.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

The extent to which significant hazards are covered is indicated in clause 1. It is indicated in greater detail in clause 4 and annex A. In addition, machinery should comply as appropriate with EN 292 for general machinery hazards which are not covered by this standard.

It is also intended to ensure that sufficient information is collected, is retained and can be made available, to enable centrifuges to be installed, commissioned, used, maintained and disposed of safely, i.e. that information is made available to users of centrifuges.

Different applications and particular centrifuge designs exist. Annex D includes more details of both of these ranges.

1 Scope

1.1 This European Standard applies to centrifuges aiming at separation of liquid/liquid/solid/solid or at least two of these substances. It gives requirements to minimise the risks caused by the hazards specified in 1.2.

The Standard deals with the significant hazards associated with the operation of centrifuges.

1.2 The Standard gives requirements for minimising the risks caused by the following hazards:

- mechanical hazards common to all types of centrifuges, except those specified in 1.3;
- ergonomical hazards;
- electrical hazards.

The standard also covers requirements for noise measurements.

1.3 Types of centrifuges and hazards excluded

1.3.1 Types of centrifuges excluded:

- centrifuges with a kinetic energy of rotation less than 200 Joule;
- centrifuges designated by their manufacturers for domestic use;
- centrifuges designated by their manufacturers as laboratory centrifuges according to EN 61010-2-020, including Amendment 1;
- centrifuges designated by their manufacturers for forming, i.e. centrifugal hot metal casting machines.

1.3.2 Hazards excluded:

- thermal hazards;
- hazards specific to processing radioactive products;
- hazards specific to microbiological processing - including viral and parasitic hazards;

- hazards from processing corrosive and/or erosive materials;
- hazards from processes involving flammable or explosive substances;
- hazards caused by leakage of hazardous substances;
- hazards caused by unsuitable hygienic design for applications involving food products;
- other application specific hazards which must be dealt with, either according to application specific standards (e.g. prEN 12505), or EN 292.

1.4 This standard applies to centrifuges which are manufactured after the date of issue of this standard.

2 Normative references

This European Standard incorporates by dated or undated references, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 292-1:1991	Safety of machinery - Basic concepts, general principles for design - Part 1: Basic terminology, methodology
EN 292-2:1991	Safety of machinery - Basic concepts, general principles for design - Part 2: Technical principles and specifications, including Amendment 1:1995
EN 294:1992	Safety of machinery - Safety distances to prevent danger zones being reached by the upper limbs
EN 418:1992	Safety of machinery - Emergency stop equipment, functional aspects - Principles for design
EN 729-2:1994	Quality requirements for welding - Fusion welding of metallic materials - Part 2: Comprehensive quality requirements
EN 729-3:1994	Quality requirements for welding - Fusion welding of metallic materials - Part 3: Standard quality requirements
EN 894-2: 1997	Ergonomics - Requirements for the design of displays and control actuators. Part 2: Displays.
prEN 894-3: 1992	Ergonomics - Requirements for the design of displays and control actuators. Part 3: Control actuators.
EN 953:1997	Safety of machinery - General requirements for the design and construction of guards (fixed and moveable)
EN 954-1:1996	Safety of machinery - Safety related parts of control systems - Part 1: General principles for design
prEN 1005-2:1993	Safety of machinery - Human physical performance - Part 2: Manual handling of objects associated to machinery
EN 1037:1995	Safety of machinery - Prevention of unexpected start-up
EN 1050:1996	Safety of machinery - Principles for risk assessment
EN 1088:1995	Safety of machinery - Interlocking devices associated with guards - Principles for design and selection
EN ISO 3744:1995	Acoustics - Determination of sound power levels of noise sources using sound pressure - Engineering method in an essentially free field over a reflecting plane (ISO 3744:1995)
EN ISO 3746:1995	Acoustics - Determination of sound power levels of noise sources using sound pressure - Survey method using an enveloping measurement surface over a reflecting plane (ISO 3746:1995)
EN ISO 4871:1996	Acoustics - Declaration and verification of noise emission values of machinery and equipment (ISO 4871:1996)
EN ISO 11203:1995	Acoustics - Noise emitted by machinery and equipment - Determination of emission sound pressure levels at a work station and at other specified positions from the sound power level (ISO 11203:1995)
EN ISO 11688-1:1995	Acoustics - Recommended practice for the design of low-noise machinery and equipment - Part 1: Planning
EN 50081-2:1994	Electromagnetic compatibility - Generic emission standard. Part 2: Industrial environment
EN 50082-2:1995	Electromagnetic compatibility - Generic immunity standard. Part 2: Industrial environment
EN 60204-1:1997	Electrical equipment of machines - Part 1: General requirements
EN 60529:1991	Degrees of protection provided by enclosures (IP Code)
EN 61310-1:1997	Safety of machinery - Indicating, marking and actuation. Part 1: Requirements for visual, auditory and tactile signals
ISO 780:1997	Packaging - Pictorial marking for handling of goods

ISO 3266:1984	Eyebolts for general lifting purposes
ISO 9614-1:1993	Acoustics - Determination of sound power levels of noise sources using sound intensity - Part 1: Measurement at discrete points
ISO 9614-2:1993	Acoustics - Determination of sound power levels of noise sources using sound intensity - Part 2: Measurement by scanning
ISO TR 11688-2:1998	Acoustics - Recommended practice for the design of low-noise machinery and equipment - Part 2: Introduction into physics of low-noise design
IEC 60364:1992	Electrical installations of buildings

3 Definitions

For the purpose of this standard, the following definitions apply:

Further definitions, giving the preferred terminology for all major parts of centrifuges and being a non exhaustive list of types of centrifuges, not necessary for the understanding of this standard, are given in annex D.

3.1 General terms

3.1.1 centrifuge: Separation device which has a rotatable chamber in which a mixture of process materials may be subjected to (radial) acceleration.

3.1.2 particular centrifuge design: Family of centrifuges which may have minor variations in the basic dimensions or speed, but with basically similar specifications and properties of materials of construction.

3.2 Parts of a centrifuge

3.2.1 drum: Chamber which holds the process material, and is arranged to rotate about its symmetrical axis.

3.2.2 hoop: Ring secured to the outer periphery of a drum to give extra strength.

3.2.3 basket: Drum used for filtration purposes.

3.2.4 bowl: Drum used for the separation of immiscible liquids and/or the sedimentation of solids.

3.2.5 rotor: Assembled part of the centrifuge which rotates, comprising drum and shaft together with their attachments.

3.2.6 casing; housing: Enclosure in which at least the drum rotates and which may constrain process materials leaving the drum to particular paths.

The casing may consist of several components.

3.2.7 casing cover; lid: Part fixed to the casing to provide access, for example for inspection, operation or maintenance.

3.2.8 discharge device: Device to induce discharge of liquids and/or solids from the centrifuge rotor.

Such a device can for example be a paring tube which discharges a liquid from a rotating rotor by dipping a fixed tube into the liquid.

3.2.9 plough; scraper: Device for the removal of centrifuged solids from the rotating drum.

3.2.10 critical components: Parts of a centrifuge that cause significant hazardous situations to develop when they fail or rupture.

3.2.11 special lifting tools: Tools tailored to the lifting and other handling requirements of a centrifuge or specific components of the centrifuge.

3.3 Operational terms

3.3.1 process material: Substances fed to a centrifuge for separation and other purposes, for example washing, purging or drying the load.

3.3.2 filling mass: Total mass of process materials in the drum at any instant.

3.3.3 maximum filling mass: Filling mass determined by the limiting features of the centrifuge - for example either drum strength or linear dimensions.

3.3.4 cleaning in place (CIP): Cleaning of equipment by impingement or circulation of flowing chemical solutions and water rinses into, onto and over surfaces in equipment or systems without dismantling, using equipment designed and installed for that purpose.

3.3.5 kinetic energy of total rotating system: Total kinetic energy of the rotor together with the filling mass at operating speed.

3.3.6 maximum/minimum (allowable) temperature: Maximum allowable or minimum allowable temperature of the process material declared by the manufacturer.

3.3.7 normal operation: Operating condition of the centrifuge, determined by specification and design, considering feed and wash rates, load, vibration, rotational speeds, etc.

3.3.8 operating speed of a centrifuge: Rotational speed measured in revolutions per unit time at which the rotor is expected to revolve either continuously or at each part of a multispeed programme.

3.3.9 purging: Removal of unwanted material from a centrifuge by means of a flushing media.

3.3.10 throughput: actual feed rate in the case of centrifuges with a continuous process material flow, or; the throughput of a centrifuge using a batch or noncontinuous process determined from the charge mass per cycle and cycle time.

3.3.11 out of balance (unbalance): unequal distribution of filling mass and/or rotor mass which produces oscillating forces during rotation.

3.3.12 service media: liquids, gases etc. used for operating the centrifuge.

3.3.13 critical speed: Characteristic speed or rotating frequency of the centrifuge at which resonance of the centrifuge system is excited.

3.3.14 run down time: Period between the time at which the stop command is initiated and the time at which the rotor has stopped completely.

3.3.15 dangerous run down time: Condition when the run down time is longer than the time needed for a skilled person to remove a guard and to reach dangerous moving parts of the machine.

4 List of hazards

The table A.1 in annex A of this standard is a list of possible significant hazards normally associated with the use of a centrifuge. The table is the result of a risk assessment carried out in accordance with EN 1050, for all centrifuges covered by the scope of this standard.

The technical measures in clause 5 and information for use in clause 7 are based on that risk assessment, and deal with the identified hazards by either eliminating them or reducing the effects of the risks they generate.

The designer shall determine which of the hazards in Annex A are applicable to their centrifuge design, paying particular attention to the intended use of the centrifuge including maintenance and cleaning, and of its reasonably foreseeable misuse.

5 Safety requirements and measures

5.1 General

Centrifuges shall be so designed and manufactured as to withstand the loads associated with the specified and reasonably foreseeable operating and maintenance conditions without endangering the safety and health of exposed persons.

This clause gives the requirements and measures for those hazards for which particular action appears necessary, either by elimination or reduction of the risk.

All hazards shall where possible be avoided by design (clause 3 of EN 292-2:1991). Where this is not possible one or several protective measures shall be taken. Any residual hazards shall be indicated by warning labels positioned adjacent to the hazard and included in the instructions for use. Where personnel protective equipment is required this shall be stated in the instructions for use.

If applicable requirements/measures are already contained in other standards, specifically in EN 292-1 and EN 292-2 or in type B1- and B2-standards, references are made to them, or to relevant subclauses.

The following parameters shall be taken into account, if applicable, for the purpose of designing, testing, inspection, operating and servicing centrifuges.

- allowed speed range;
- maximum filling mass;
- maximum and minimum through-put;
- starting, stopping, feeding and discharging sequences (cyclic loading);
- allowable ambient temperature range;
- limits in application (for example related to corrosive, erosive, explosive/flammable and toxic properties of the material to be processed by the centrifuge);
- allowable process material temperature range;
- minimum and maximum casing pressure;
- out of balance or vibration limits (dangerous movement);
- maximum power input;
- requirements and limitations regarding installation and connections (for example foundation, piping, ducting loading);
- corrosion and wear allowance on critical components;
- allowable dimensions on critical components;
- inspection/replacement intervals for safety related parts (see example in 5.7);
- inspection/replacement intervals for critical components.

5.2 Mechanical hazards

5.2.1 Ejection of parts

Three types of ejection of parts can occur:

- debris or major parts of the rotor are ejected due to a rotor rupture;
- parts come loose from the rotor and are ejected;
- stationary parts are ejected.

The manufacturer shall give in the instructions for use details of inspection, operation and maintenance (see clause 7).

5.2.1.1 Rotor rupture

The centrifuge shall be so designed and manufactured that:

- a) the casing is capable of containing a ruptured rotor, for example a casing constructed of steel withstanding and containing the energy of the ruptured rotor parts and reducing the energy by friction between the rotor parts and the casing, or by deforming of the rotor parts and/or the casing
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 and/or;
- b) there is no risk of a rotor rupture.

To support the latter case centrifuge rotors shall be manufactured from suitable materials with verified properties considering the operating environment (e.g. temperature, corrosion and erosion) and steady and/or cyclic loading:

Case 1 - Steady loading

The rotor shall be designed according to procedures specified by the manufacturer. The manufacturer shall ensure a safety margin against general yielding and rupture, taking into account the steady loading due to the rotation of the rotor mass and the maximum filling mass.

The strength of cylindrical baskets or bowls may be determined using the method of analysis specified in annex B provided that the loading, geometry and material of construction satisfies the requirements stated in the annex. For stress analysis of more complex geometry's an elastic-plastic FEM (Finite Element Method) or BEM (Boundary Element Method) calculation is considered to be the most suitable.

If a drive mechanism is employed which would drive the centrifuge at a speed higher than its maximum permissible speed, such as a frequency converter and a hydraulic drive, a speed control and an overspeed prevention device to prevent the rotor from exceeding the maximum permitted speed shall be provided, see 5.7.

Case 2 - Cyclic loading

The rotor shall be designed with a safety margin against fatigue failure.

Stresses which shall be considered in a fatigue evaluation are:

- bending stresses in horizontal rotors caused by the weight of the rotor;
- bending stresses in rotors caused by external forces such as loads from belt drives etc;
- stresses caused by cyclic loading of the centrifuge (for example related to intermittent loading and discharging of process materials);
- stresses caused by unbalanced forces of rotors, in particular in the case of dual rotor systems;

All other cyclic loads acting on the rotor, known by the manufacturer, shall be considered.

The operating load acting on a rotor as a result of the start/stop cycle of a centrifuge shall be considered as a cyclic load. The load and expected number of cycles shall be assessed to determine if this will lead to fatigue failure during the foreseeable life of the centrifuge.

Stress raisers such as sharp edges, perforations, rough surfaces (scores, grinding cracks etc.) and bores shall be avoided in regions subjected to high cyclic stresses.

All peak stresses at perforations or discontinuities shall be considered in the evaluation of the safety margin against fatigue failure.

The difference in the condition of the actual rotor material and the test material shall be considered in the evaluation of the safety margin against fatigue failure. The differences in actual service and test conditions and differences in microstructure, purity, residual stress etc. between the two materials shall be included in the consideration.

The welding of all seams important to the integrity of a rotor shall be carried out in accordance with the requirements in EN 729-2 or EN 729-3.

The reduction of fatigue strength for welded seams subject to cyclic loading shall be considered. The requirements in 4.3 of annex B for welded joints are applicable only for static strength evaluation. Additional requirements may be necessary to account for reduction of corrosion and fatigue resistance.

All welded seams on parts subjected to cyclic loads shall be machined to remove end craters, weld undercuts and arc strikes.

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5.2.1.2 Ejection of rotor parts

The risk of any rotor parts coming loose and being ejected (and the possible consequential discharge of high kinetic energy process material; see also 5.2.2) from the centrifuge shall be dealt with by:

- a) having a casing capable of containing loosened or broken rotor parts, for example a casing manufactured of steel withstanding and containing the energy of the parts and reducing the energy by friction between the parts and the casing, or by deforming of the parts and/or the casing

and/or by;

- b) ensuring that mechanical connections between rotor parts and connections of parts attached to the rotor can withstand all foreseeable loads on the connections with a safety margin considering the operating environment of the connection.

Connections and attached parts subjected to cyclic loading shall have a fatigue life that exceeds the foreseeable service life with a safety margin.

All steady and cyclic loads on mechanical connections between rotor parts, as mentioned in 5.2.1.1, shall be considered.

When screwed and/or bolted connections are used for connecting rotor parts subjected to pressure loading from the filling mass, the screws shall be able to carry the sum of the pressure load and other loads on the connection related to the operation of the centrifuge, with a safety margin against rupture of the screws.

All thread type joints subjected to vibration and cyclic loads shall be secured against coming loose by pretensioning. The tightening torque for all critical joints requiring pretensioning shall be specified by the manufacturer.

The design for screwed and/or bolted joints requiring pretensioning shall be such that there is no risk of loss of pretensioning due to settling in the joint and indentation below screw heads and nuts.

The design of screwed and/or bolted connections should follow approved standards.

If it is not possible to secure a joint by pretensioning, it shall be secured against coming loose by a safe positive locking device, or by a method with an equal safety margin.

The possibility of corrosion and erosion on the parts in the connection shall be considered at the design of mechanical connections.

The manufacturer shall specify precautions and inspection/replacement criteria for the parts of the connections between rotor parts subjected to corrosion and/or erosion.

5.2.1.3 Ejection of stationary parts

The risk of stationary parts or debris of such parts being ejected from the centrifuge as a consequence of heavy out of balance or vibration, ejection of rotor parts or a rotor rupture, or as a consequence of those stationary parts failing and/or loosening and being accelerated by the rotor and ejected (and the possible consequential discharge of high kinetic energy process material; see also 5.2.2) shall be dealt with by:

- a) having a casing capable of containing loosened and accelerated stationary parts, for example a casing manufactured of steel withstanding and containing the energy of those parts and reducing the energy by friction between those parts and the casing or by deforming of those parts and/or the casing

and/or by;

- b) employing specified and well controllable methods for fastening critical stationary components and ensuring that any critical part and its attachments subjected to high or low frequency cyclic loading have a fatigue life exceeding the specified or foreseeable service life with a sufficient margin.

A centrifuge which operates at more than one speed, and which incorporates a discharge device which is inadequate for operation within a certain speed range, shall be provided with an interlocking device to prevent the plough or other discharge device from leaving the parked position, until a safe rotational speed is achieved.

The manufacturer shall specify the maximum allowable operating out of balance or vibration level and, if necessary, how the centrifuge shall be accelerated or decelerated through any critical speed.

Centrifuges shall be designed and manufactured in such a way as to safely withstand, for a short duration of time, an excess out of balance or vibration level determined by the manufacturer, during start-up, operation (duration at least 1 h) and run-down. If a particular centrifuge design cannot be operated safely with such an excess out of balance or vibration level, means for detecting and preventing these conditions shall be provided.

It may be necessary to keep the bowl filled, and/or maintain a flow, during the stopping period of a centrifuge, in order to avoid hazards due to vibration or unbalance conditions.

Centrifuges charged manually and/or operated with frequent starts and stops and centrifuges which can be

affected dangerously by out of balance forces shall be equipped with a decelerating device. The decelerating device shall be so designed that the time taken to pass through any critical speed will be so short that the vibration energy will not develop hazardous movement. Examples of such decelerating devices are mechanical brakes, water brakes, hydraulic brakes, pneumatic brakes, electrical motor brakes and magnetic brakes.

5.2.2 Ejection of high kinetic energy process material or service media

Centrifuges shall be so designed and installed that neither solids, liquids, gases nor fumes can escape under normal and predictable circumstances if such an escape can cause impact hazards.

An example where the risk of such impact hazard has to be considered is for the solids outlet at centrifuges where the solids leave the drum at the periphery. Depending on the design of the drum the solids may leave the outlet at a velocity close to the peripheral velocity of the drum. There are several ways to dissipate the kinetic energy. One way is to use a cyclone where the solids can rotate until their velocity is reduced. Another way is to design the drum casing in such a way that the velocity is reduced in a similar way by rotation inside the casing. A third way is to use a closed receiving system strong enough to handle the high velocity.

If a centrifuge is equipped with covers or hatches that need to be removed for cleaning or service when the centrifuge is at a standstill, but can cause a hazard by escape of material if they are removed when the centrifuge is running, then those covers or hatches shall be designed according to the requirements in 5.2.6. Examples of such openings are for cleaning and inspection at the top of a solids outlet cyclone and openings in the bowl cover for cleaning and inspection of the nozzles of a nozzle centrifuge.

A hazard caused by escape of process or service media can occur if a connection between the centrifuge and other equipment is damaged. These connections shall be designed to withstand the forces to which they can be exposed. If for example the centrifuge is designed to be mounted on vibration isolators the connections shall be designed in such a way that the forces which are transmitted to the connections when the centrifuge moves, will not cause fracture.

If short hoses are used to give flexibility they have normally a very low flexibility in the axial direction especially when exposed to pressure. They should be mounted in such a way that the movement will be in the radial direction.

Centrifuges which have a discharge device that can give a high pressure in predictable circumstances (for example a paring tube working against a closed valve), shall have connections designed for this pressure or means shall be provided to prevent the occurrence of this pressure.

5.2.3 Dangerous movement and vibration

5.2.3.1 General

Requirements for flexible connections shall be specified (process media, service media and electrical connections). The electrical aspects of dangerous movement and vibration are covered in 5.3.3.

Means of protection, e.g. prevention of access shall be provided if crushing hazards exists between the centrifuge, or parts of the centrifuge, and its surrounding area.

Instructions shall be provided in the "Information for use", see clause 7.

5.2.3.2 Centrifuges not fixed to a foundation

Centrifuges that are not fixed to a foundation shall be so designed that they do not move more than 300 mm under the influence of specified and predictable out of balance forces, or reaction forces from discharge of materials.

5.2.3.3 Centrifuges fixed to a foundation

The manufacturer shall specify foundation fastening principles for fixed centrifuges that are to be fixed to a foundation to ensure that the centrifuge can withstand the actual forces and thereby ensure stability.

5.2.4 Transportation

Centrifuge crates shall be marked with the weight of the crate, the location of the centre of gravity, the location of securing positions (if applicable) and the location of lifting position if the transportation weight exceeds 25 kg (see figure 1).

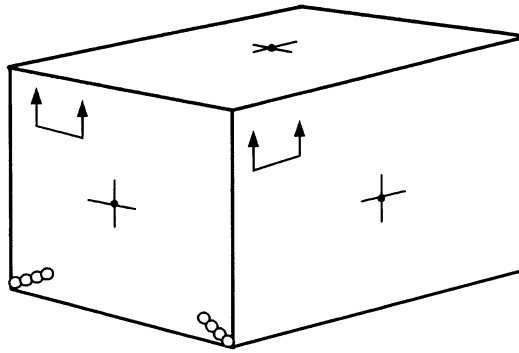


Figure 1: Example of indication on crates

The graphical symbols used shall correspond to ISO 780.

5.2.5 Lifting

Instructions for lifting the centrifuge out of a centrifuge crate shall be included with each centrifuge in an easily accessible position in the crate, and that position shall be indicated on the crate.

Instructions for lifting the complete centrifuge, the rotating assembly and other major sub-assemblies, with a total weight of 15 kg or more respectively, shall be provided in the instruction manual. See also prEN 1005-2 and ISO 780.

If the centrifuge requires special lifting tools, these shall be referred to in the instruction manual.

Eyebolts, if applicable, shall be made according to ISO 3266.

5.2.6 Access to moving parts

It shall be possible to determine if the rotor is turning, as it can take a considerable time to come to a complete stop after the power has been cut.

The instructions for operation shall specify the use of a power supply disconnecting device according to 5.1 of EN 1037:1995 for access associated with maintenance or repair.

Centrifuges shall be so designed that moving parts are not accessible accidentally during operation. Openings in guards shall be designed according to 4.5.1 of EN 294:1992 and selected according to the criteria in table 1. Principles for the design of interlocking guards and interlocking guards with guard locking shall be according to EN 1088, EN 953 and EN 954-1.

The manufacturer shall indicate the expected run down time of the centrifuge, if necessary in various predictable circumstances, as the run down time of a centrifuge is longer than for most rotating machines of similar size.

The guard requirements of different types of openings shall be according to table 1.

[SIST EN 12547:2000](https://standards.iteh.ai/catalog/standards/sist/e60174f3-0f4e-4444-ba84-7fad4c68594f/sist-en-12547-2000)

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