
Safety requirements for dry-cleaning machines using perchloroethylene

*Exigences de sécurité pour les machines de nettoyage à sec utilisant du
perchloroéthylène*



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International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland
Internet central@iso.ch
X.400 c=ch; a=400net; p=iso; o=isocs; s=central

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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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 8230 was prepared by Technical Committee ISO/TC 72, *Textile machinery and machinery for dry-cleaning and industrial laundering*, Subcommittee SC 5 *Industrial laundry and dry-cleaning machinery*.

Annex A of this International Standard is for information only.

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Introduction

This International Standard is intended to instruct the designer of dry-cleaning machinery in a systematic manner regarding the relevant essential safety requirements and to suggest possible solutions representing the state of the art with respect to safety.

The extent to which hazards are covered is indicated in the scope of this International Standard. The manufacturer's attention is drawn to the fact that machinery should comply as appropriate with ISO/TR 12100-1 and ISO/TR 12100-2 for hazards which are not covered by this International Standard.

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Safety requirements for dry-cleaning machines using perchloroethylene

1 Scope

This International Standard is applicable to closed-circuit dry-cleaning machines of all sizes intended for industrial use (including retail shop operation) for the cleaning of articles made of textile, leather, furs and skins, using perchloroethylene¹⁾ (commonly shortened to perc) only as liquid solvent.

This International Standard is not applicable to:

- machines placed at the disposal of the general public (e.g. self-service);
- open-circuit dry-cleaning machines using perc and working below atmospheric pressure;
- barrier machines;
- ironing presses (see ISO 10472-1 and ISO 10472-6);
- machines with automatic doors;
- ancillary equipment, e.g. room evacuation equipment, waste recuperation systems of the still, external water cooling systems or complementary systems for perc recovery from the oil in the still.

This International Standard identifies all significant hazards arising from the use of the machine with special emphasis on solvent hazards, where "use of the machine" comprises both intended use and foreseeable abnormal situations. No specific technical advice is given for hazards (apart from the use of the machines) arising during construction, transport and commissioning, decommissioning, dismantling and disposal of the machines.

This International Standard applies primarily to machines manufactured after the date of issue of this standard.

It does not give specific technical advice about:

- pneumatic systems;
- noise;
- hazards caused by processing work which may create an explosive atmosphere (e.g. printers' wipers containing a low-flash solvent);
- machines processing loads which may contain "foreign solvents" which could lead to a change in a property (characteristic) of the cleaning solvent perc, e.g. cause foaming or make it carcinogenic;
- hazards caused by neglect of ergonomic principles;
- measures dealing with the containment of pressure in the machine.

The guidance contained in this International Standard is based on the presumption that the designer has completed a risk analysis of the machine under consideration, see EN 1050. This will enable him to identify and fulfill the significant requirements for his machine as stipulated by this International Standard.

Where for clarity an example of a safety measure is given in the text, this should not be considered as the only possible solution. Any other solution leading to the same risk reduction is permissible if an equivalent level of safety is achieved, evidence of which should be given in the manufacturer's documentation.

1) IUPAC name tetrachloroethene, chemical formula $\text{Cl}_2\text{C} = \text{CCl}_2$

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 5232:—²⁾, *Graphical symbols for textile machinery*.

ISO 6178:1983, *Centrifuges — Construction and safety rules — Method for the calculation of the tangential stress in the shell of a cylindrical centrifuge rotor*.

ISO 8232:1988, *Closed-circuit dry-cleaning machines — Defining and checking of machine characteristics*.

ISO 10472-1:1997, *Safety requirements for industrial laundry machinery — Part 1: Common requirements*.

ISO 10472-6:1997, *Safety requirements for industrial laundry machinery — Part 6: Ironing and fusing presses*.

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

ISO/TR 12100-1:1992, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology*.

ISO/TR 12100-2:1992, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles and specifications*.

ISO 13849-1:—³⁾, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design*.

ISO 13850:1996, *Safety of machinery — Emergency stop — Principles for design*.

ISO 13852:1996, *Safety of machinery — Safety distances to prevent danger zones from being reached by the upper limbs*.

ISO 13853:—³⁾, *Safety of machinery — Safety distances to prevent danger zones being reached by the lower limbs*.

ISO 14119:—³⁾, *Safety of machinery — Interlocking devices associated with guards — Principles for design and selection*.

EN 614-1:1995, *Safety of machinery — Ergonomic design principles — Part 1: Terminology and general principles*.

EN 953:1997, *Safety of machinery — General requirements for the design and construction of guards (fixed, movable)*.

EN 983:1996, *Safety of machinery — Safety requirements for fluid power systems and components — Pneumatics*.

EN 1037:1995, *Safety of machinery — Isolation and energy dissipation — Prevention of unexpected start-up*.

EN 1050:1996, *Safety of machinery — Risk assessment*.

EN 60204-1:1992, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*. [IEC 204-1:1992, modified].

²⁾ To be published. (Revision of ISO 5232:1988)

³⁾ To be published.

3 Definitions

For the purposes of this International Standard, the following definitions apply :

3.1

dry-cleaning machine

Machine in which articles made of textile, leather, fur and skins are cleaned using perc only as solvent.

3.1.1

open-circuit dry-cleaning machine

Dry-cleaning machine in which deodorisation takes place by an intake of fresh air and evacuation of any perc/air mixture out of the machine, prior to the opening of the loading/unloading door.

3.1.2

closed-circuit dry-cleaning machine

Dry-cleaning machine which complies with ISO 8232, in which deodorization is carried out without any contact between the air in the drum and the air in the workroom.

3.1.3

barrier dry-cleaning machine

Dry-cleaning machine designed in such a way that, for reasons of hygiene, direct or indirect contact between clean articles and dirty articles is avoided by a partition.

NOTE — This is the case in particular with machines with two doors (one front door and one side door) in which loading and unloading are carried out on opposite sides of this partition.

3.2

drum

Enclosure or container in which the cage rotates.

3.3

G-factor

Dimensionless quotient of the centrifugal acceleration at the outer cage diameter and the gravitational acceleration, obtained by the formula:

$$G = 5,6 \cdot \left[\frac{n}{1\,000} \right]^2 \cdot d$$

where

n is the rotational frequency, in reciprocal minutes;

d is the cage diameter, in centimetres.

3.4

cage

Rotating perforated cylinder, totally enclosed by the drum, in which the load to be cleaned is placed.

NOTE — The capacity of the cage is defined in ISO 8232.

3.5

drying system

All parts of the dry-cleaning machine comprising the circuit through which a current of air flows which is heated and cooled in fixed sequences in order to recover the perc contained in the articles at the end of cleaning.

3.6

deodorization

Reduction of perc concentration in the treated goods and in the air of the cage after the drying phase.

3.7**drying condenser**

Component of the drying system which cools a current of air and condenses perc vapour and water vapour contained in that air.

3.8**still condenser**

Component of the distillation circuit which condenses and cools perc vapour and water vapour after vaporization.

3.9**water separator**

Component of the dry-cleaning machine which separates the mixture from the condenser into a layer of water and a layer of perc.

NOTE - The water layer contains a low concentration of dissolved perc because this is slightly soluble in water.

3.10**still**

Component of the dry-cleaning machine which heats and evaporates solvent and water from dirty solvent, leaving the dirt in the still.

3.11**tank**

Container of the dry-cleaning machine, to store used perc for the cleaning process, designed to withstand the stress to which it is subjected and the chemical effects of perc.

3.12**lint filter**

Mechanical device for removing lint and particles from the air during the drying phase.

3.13**solvent filter**

Mechanical device for removing particles from the liquid perc during the washing phase.

3.14**button trap filter**

Mechanical device for protecting the solvent pumps from solid objects during the washing phase.

4 Hazards

This International Standard concerns primarily solvent hazards (perc emission to the workroom). Other hazards are mentioned with appropriate references, as an aid to the designer.

4.1 Hazards associated with the use of dry-cleaning machines**4.1.1 Mechanical hazards**

4.1.1.1 Moving drive components: shearing, entanglement or trapping.

4.1.1.2 Rotating cage: shearing, entanglement or trapping.

4.1.1.3 Ejection of machine parts: impact.

4.1.2 Electrical hazards

4.1.3 Hazards caused by failure of services (heating, power, compressed air, coolant)

4.1.4 Thermal hazards

4.1.4.1 Hot surfaces: burns.

4.1.4.2 Steam-heated surfaces: burns.

4.1.4.3 Components using thermal fluid at atmospheric pressure: burns.

4.1.4.4 Components using pressurized fluid: burns.

4.1.5 Hazards generated by noise

4.1.6 Hazards generated by machine vibration: machine breakdown and/or machine movement, impact

4.1.7 Hazards generated by perc

The following hazards can lead to inhalation of unhealthy vapour and perc contact with skin (including feet) and eyes by the machine operator, other personnel and members of the public on the premises, as well as contamination of water and ground.

4.1.7.1 Perc emission when the loading/unloading door is opened.

4.1.7.2 Evaporation of perc outside the machine from work which has not been dried sufficiently.

4.1.7.3 Perc emission to the workroom, seepage into the ground and the sewer during operation and maintenance of the water separator.

4.1.7.4 Perc emission from rotating joints, door hatch seals and flexible tubes.

4.1.7.5 Perc emission resulting from cleaning of the lint filter.

4.1.7.6 Perc emission resulting from cleaning of the button trap.

4.1.7.7 Perc emission resulting from cleaning and maintenance of the solvent filter.

4.1.7.8 Perc emission resulting from operation, cleaning and maintenance of the distilling installation.

4.1.7.9 Perc emission when filling or topping-up tanks.

4.1.7.10 Perc emission resulting from faulty operation.

4.1.7.11 Perc emission resulting from cooling failure in the drying system.

4.1.7.12 Spillage of perc from machine, giving free flow across the floor.

4.1.7.13 Thermal breakdown of perc into toxic products.

4.1.8 Hazards due to neglect of ergonomic principles in machine design

4.2 Hazards associated with phases of "life" of a machine other than use

5 Safety requirements and/or measures for the hazards identified in clause 4

5.1 Hazards associated with the use of dry-cleaning machines

5.1.1 Mechanical hazards

Guards shall comply with table 1.

Table 1 — Safety requirements and /or measures for guards

Application	Reference
Guard selection	ISO/TR 12100-2:1992, 4.1 EN 953:1997, clause 5
Guard design and construction	ISO/TR 12100-2:1992, 4.2 EN 953:1997, clauses 6 and 7
Guard fastening	EN 953:1997, 5.4, 7.2 and 7.3
Guard arrangement	ISO 13852:1996, tables 1 and 4 ISO 13853
Guard interlocking	ISO 14119:—, clause 5

5.1.1.1 Moving drive components

Access to the drive shall be prevented by the body of the machine and/or guards. Guards shall comply with table 1.

5.1.1.2 Rotating cage

Access to the cage shall only be possible at standstill through the door(s).

The door(s) shall be fitted with an interlocking device with guard locking in accordance with ISO 14119:—, clause 5, e.g. in combination with a motion sensor or time delay, so that it is not possible to open the door until motion has stopped.

The category of the control system for this function shall be 3 or 4 in accordance with ISO 13849-1:—, clause 6.

5.1.1.3 Ejection of machine parts

Means of preventing hazards resulting from the rupture of components and/or projection of fragments under the effect of rapid rotation shall be integrated in the machine design as follows:

- the assembly, particularly shafts and bearings, shall be capable of withstanding the maximum force to which it can be subjected in use under the conditions stated by the manufacturer in the instruction handbook and take into account the foreseeable effects of fatigue, corrosion and ageing;

— for dry-cleaning machines with a G -factor greater than 100, the tangential stress on the shell of the cage shall be calculated in accordance with ISO 6178.

5.1.2 Electrical hazards

The safety requirements of EN 60204-1:1992, option 1, shall apply as described in table 2.

Table 2 — Safety requirements and/or measures for electrical equipment of machines

Safety requirements and/or measures concerning:	See EN 60204-1:1992, clause:
Electric shock	4, 6, 7, 8, 15, 16 and 18
Overcurrent, overspeed and overload	7 and 8
Environmental influences	4, 13 and 16
Electromagnetic compatibility	4, 8 and 9
Restart after voltage drop or supply interruption	7.5
Accessibility, layout and identification of control equipment	10, 13 and 18
Ergonomics for manual operation	10 and 13
Cabling and wiring	14 and 15
Accessories and lighting	17
Documentation and instruction handbook	19
Machine testing	20
Degree of protection	13.3

Safety-related parts of the control system shall conform to category 1, see ISO 13849-1:—, clause 6, unless otherwise specified for specific safety functions.

An emergency stop device shall be provided which complies with the specific requirements of ISO 13850. The emergency stop device shall cause all machine functions to cease except the provision of cooling.

The general shut-down of the machine shall be lockable in accordance with EN 1037.

5.1.3 Failure of services

In the event of failure of one or more services (heating, power, compressed air or coolant), the machine shall go automatically to a safe condition, i.e.:

- the door shall remain locked in the closed position; it shall be openable by means of a tool;
- all valves presenting a risk of perc leakage outside the machine shall automatically return to a safe position;
- in case of intentional or unintentional stop during the cycle, the choice of operating sequence for restarting shall be the result of manual intervention on the part of the operator;
- the cooling water flow shall be monitored so that if cooling water flow or pressure is not maintained then the machine will automatically shut down, see 5.1.7.8 h) and 5.1.7.11.

The pneumatic system shall conform to EN 983:1996, clause 5.

5.1.4 Thermal hazards

5.1.4.1 Hot surfaces

The risk of burns from contact with hot surfaces shall be eliminated by keeping surface temperatures below the following values:

— uncoated metal	70 °C
— coated metal (e.g. paint thickness 60 µm)	80 °C
— glass	85 °C

Where this is not possible, the surfaces shall be guarded, shielded or insulated.

Where, for technical reasons, total protection cannot be provided by design (e.g. still sight glass), a warning shall be given on the machine and information shall be given in the instruction handbook concerning instruction and training of operators and the use of personal protective equipment.

5.1.4.2 Steam-heated surfaces

The manufacturer shall give technical information in the instruction handbook about an isolating valve to shut off the steam supply. Steam pipes shall be insulated.

5.1.4.3 Systems using thermal fluid at atmospheric pressure

In order to avoid an excessive fluid temperature, this shall be controlled by a thermostatic heating regulator acting directly on the power control of the heater.

The maximum temperature given by the adjustment range of the thermostat shall be below the maximum operating temperature of the thermal fluid recommended by the thermal fluid manufacturer. The temperature of the thermal fluid shall be measured independently to control the correct running of the thermostat, and alarm shall be given below the limit of the operating temperature due to thermostat fault. The instruction handbook shall contain information on appropriate actions.

An expansion vessel or an expansion volume shall be fitted on the heating chamber or the heating chamber shall be large enough to accommodate, without overflow, the increase in the volume of thermal fluid associated with the maximum temperature setting of the thermostat. The vessel shall permit the level of thermal fluid at the regulator temperature to be checked, e.g. by direct reading.

Valves for controlling the thermal fluid shall be closed while the machine is at standstill, e.g. by using automatic valves of the normally closed type.

Advice shall be given in the instruction handbook for periodic cleaning of the venting pipe, e.g. once per year to avoid an eventual blockage.

5.1.4.4 Systems using pressurized fluids

Flexible components or components made of fragile material (e.g. glass) and containing hot pressurized fluids (steam, water or oil) shall be designed to prevent direct spraying in the event of leakage or rupture or shall be shielded.

5.1.5 Hazards generated by noise

This International Standard does not contain specific measures concerning noise reduction. At an early stage of design, consideration should be given to the possible noise hazard likely to arise. The selection of appropriate measures should be based on the latest state of technology (ISO/TR 11688-1).

5.1.6 Hazards generated by machine vibration

The prevention of the effects of vibration shall be provided by design (adequate strength of the various parts of the machine and floor anchorages) according to the probability of maximum imbalance created by the nominal load of articles when unevenly distributed. This also applies to machines equipped with an automatic balancing system.

5.1.7 Hazards generated by perc

The means described for closed-circuit machines aim to minimize inhalation of perc vapour by the machine operator(s), other personnel and members of the public on the premises.

A means shall be provided and appropriate advice given in the instruction handbook so that the power supply to the machine can be interlocked with the work room ventilation. This shall ensure that the machine cannot be operated without ventilation being turned on.

5.1.7.1 Opening of the loading door

Opening of the door shall not be possible once perc has entered the drum, and the door shall remain interlocked with guard locking until drying and deodorisation phases have been completed, see 5.1.7.2, and ISO 14119:—, clause 5, and the safety category in 5.1.1.2 shall apply.

5.1.7.2 Evaporation of perc from work that has not been dried sufficiently

It shall not be possible to withdraw the articles from the machine other than in a dried and deodorised state. An equal degree of drying of each load shall be obtained, e.g. by controlling the flowrate of the recuperated solvent and the time allowed for subsequent completion of drying.

A deodorization phase shall follow only when the drying phase is completed. An equal degree of deodorization shall be obtained, e.g. by controlling the duration or temperature or solvent concentration in the cage.

If the drying and deodorization phases have not been completed properly due to a faulty condition, e.g. service failure, overload of work, pump failure, etc., advice shall be given in the instruction handbook on:

- how to open the door with a tool (by trained maintenance personnel only);
- how to remove the work from the cage in a manner safe for the operator and other personnel on the premises;
- how to return to the regular cycle operation after fixing the fault.

The occurrence of a technical fault which interrupts drying shall be clearly indicated visually or acoustically and shall cause the cycle to stop.

A means shall be provided to enable measurement of the residual concentration of perc in the drum air while the loading door is closed, with a load temperature above 35 °C and with nominal air flow.

NOTE — National regulations for perc concentration in the machine at the end of the cycle may exist, which requires specific technical features.

The nominal load (see ISO 8232) of the cage shall be marked with a label on the loading door to alert the operator to the risk of inadequate drying of work if the machine is overloaded. The wording of this label shall be reproduced in the instruction handbook.

5.1.7.3 Perc emission to the workroom, and seepage into the ground and the sewer during operation and during maintenance of the water separator

The water outlet of the separator shall lead through a pipe into a sealed collecting tank to avoid the loss of perc in case of fault.

The capacity of the water-collecting tank shall be not less than one day's production. It shall be possible to detect the presence of perc in the tank, e.g. by means of a sight glass. A label on the collecting tank shall indicate that the water contains perc. The wording of this label shall be reproduced in the instruction handbook.

The instruction handbook shall require safe draining of any perc into the machine, and draining of the water once per day.

Drainage from a water separator and any associated collecting tank shall be possible either via a manual valve which closes automatically when released or via a direct return circuit to the still or other reservoir.

5.1.7.4 Perc emission from rotating joints, door hatch seals and flexible tubes

All materials used in rotating joints, door hatch seals and flexible tubes that may come into contact with perc liquid or perc vapour shall be resistant to perc.

Components that provide a resilient seal shall be capable of maintaining their resilience over the recommended maintenance intervals.

Components, including flexible tubes, shall be strong enough to withstand the mechanical forces encountered in use, shall resist failure from fatigue or abrasive wear over recommended maintenance intervals and shall be resistant to perc.

5.1.7.5 Perc emission during cleaning of the lint filter

A label placed next to the access door shall state that the lint filter has to be cleaned when the machine is at standstill and preferably cold. The wording of the label shall be reproduced in the instruction handbook.

An interlocking device in accordance with ISO 14119:—, 5.3, 5.4 shall prevent the operation of the machine if the door of the lint filter is open or incorrectly closed. This interlocking device shall be of category 1, see ISO 13849-1:—, clause 6.

5.1.7.6 Perc emission during cleaning of the button trap

The provisions of 5.1.7.5 for the lint filter shall apply to the button trap also. The housing of the button trap shall be designed so as to prevent overflow of perc in the event of accidental opening during operation.

5.1.7.7 Perc emission during operation, cleaning and maintenance of the solvent filter

The opening of solvent filters shall only be possible by means of a tool. The opening device shall work sufficiently slowly for any inadequate drainage of the filter to be detected. Solvent filters shall be positioned so as to avoid spillage or overflow of perc when the housings are opened, e.g. vertical, with top opening, or horizontal, with front opening and a trough fixed so as to drain the perc back into the machine.

The outlet of the vents permitting filling of the filters shall open into the interior of the machine and not into the atmosphere of the work room.

A pressure gauge shall be fitted on the high-pressure side of the filter. Seals shall be able to withstand the highest pressure that the solvent pumps can generate.

NOTE — National regulations requiring or forbidding the use of certain types of filters may exist.

5.1.7.8 Perc emission resulting from operation, cleaning and maintenance of the distilling installation

- a) The still chamber, the still chimney and the still condenser shall be large enough to avoid blockage by solids. The still chimney and still condenser shall be readily accessible for cleaning. This can be achieved if the coolant flows through the inside of the condenser coil and the still chimney has a minimum inside diameter taken from table 3.

Table 3 — Minimum inside diameter of still chimney

Maximum still throughput l/min	Minimum inside diameter of still chimney mm
≤ 3,9	42
4,5	45
6,3	53
10,6	69
14,3	80

- b) The still chimney shall be fixed at the highest point of the still chamber. When pressure-relief valves are used for an emergency, the instruction handbook shall instruct the user to pipe away the exhaust without polluting the workroom, e.g. to the outside.

NOTE — The safety provisions for pressure vessels should be observed.

- c) A still pressure-relief device shall be capable of releasing excess pressure by evacuating the volume of gas generated by distillation at maximum rate. The pressure-relief device shall be capable of being tested. The instruction handbook shall describe the test procedure. Operation of the pressure-relief device shall cut off the heating of the still.
- d) An automatic control system shall:
- prevent overfilling the still (above 75 % of the capacity), e.g. by closing the inlet valve, and
 - cut off the heating in case this perc level limit is exceeded, e.g. due to filling by hand-operated valves.

Heating may only be restarted when the perc level is below this 75 % limit.

- e) The still door shall be fitted with an interlocking device preventing operation of the machine if it is open or incorrectly closed, see ISO 14119:—, 5.3, 5.4. This interlock shall be of category 3 or 4, see ISO 13849-1:—, clause 6.
- f) The temperature of the still heating surface shall not exceed 150 °C.
- g) If manual valves are provided for air or steam injection into the still, these shall return to the closed position when released by the operator.
- h) The coolant flow shall be interlocked with the heating of the still in such a way as to stop heating when the coolant flow is reduced below a safe limit and to produce a visual or acoustical alarm. This can be achieved, e.g. by a pressure sensor in the coolant service or a sensor of the solvent condensate temperature. This temperature shall not exceed 55 °C.

- i) If a manual drain valve is installed to empty the still in the event of breakdown and to reduce the oily residue prior to opening the access door for cleaning, it shall return automatically to the closed position when released by the operator.
- j) An observation window shall be fitted, equipped with a light source, for viewing the distillation phase and the state of the residues before opening the door for cleaning. The observation window shall allow checking of the contents level in the still. The maximum level shall be durably and clearly marked on the sight glass. The observation window shall be such that in the event of breakage the still chamber is not exposed to the air, or shall be sufficiently tough to resist breakage, e.g. safety glass or glass reinforced by a screen.
- k) Means, e.g. by bolts and tools, shall be provided for preventing the sudden wide opening of the access door until the operator is satisfied that it is safe to proceed. Any slight escape of liquid shall not interfere with the possibility of manually closing the door rapidly.
- l) The access door shall permit the rapid evacuation of residues into a lidded container of size, shape and capacity suitable for transporting it to a storage zone so as to minimize perc emission. This container shall be supplied with the machine.

A connection shall be provided to allow, if required, safe disposal of residue by piping directly away from the still without perc emission.

- m) A label, placed on or next to the access door for cleaning, shall state that cleaning shall always be carried out with the machine not in operation and with the still at room temperature. The label shall be reproduced in the instruction handbook.

5.1.7.9 Perc emission when filling or topping up tanks

The solvent tanks shall be interconnected to permit overflow from one into another. The interconnection shall be placed at the highest possible level on the tanks.

The solvent tanks shall be fitted with level indicators showing the actual contents level and the maximum permissible level clearly and durably marked; these level indicators shall be visible to the operator whilst filling.

It shall be possible to carry out the filling operation by means of the perc pump of the machine via suction and gas displacement channels which can be locked by means of manual valves which close when released.

5.1.7.10 Perc emission resulting from faulty operation

A mode selector shall be fitted to prevent activation of the manual control and the automatic control at the same time, see ISO/TR 12100-2:1992, A.1.2.5.

The machine controller may be capable of executing a preprogrammed sequence of stages automatically.

The machine shall be capable of being operated manually, e.g. to execute an additional drying stage.

Interlocks within the control system shall be provided to prevent the machine proceeding to an unsafe condition as the result of incorrect programming.

It shall be possible to determine, by visual inspection of the control panel, the stage reached in the cleaning cycle, e.g. by position of the card in a card controller, by the lights illuminated on a mnemonic panel or by an appropriate display on a computer panel.

Inspection doors shall be openable only by means of a tool.

Parts of the machine liable to release liquid perc and which have an inspection door shall have means of displaying the level of perc.

5.1.7.11 Perc emission resulting from cooling failure in the drying system

The coolant flow shall be interlocked with the heating of the drying system in such a way as to stop the drying and/or deodorisation phase when the coolant flow is reduced below the rate required by the manufacturer for these operations, e.g. by a pressure sensor for the water service.

The machine shall automatically stop in a safe condition and a visual and/or acoustical warning signal shall be given. For restarting the machine see 5.1.3.

5.1.7.12 Major spillage of perc from the machine

In order to restrict the free flow of perc in the event of an accident, the machine shall be placed on a spillage tank that is impermeable to perc and strong enough to withstand the forces transmitted by the machine.

The spillage tank capacity shall be either half the total capacity of the tanks, or the full capacity of the largest tank, whichever is greater, and shall be high enough to leave a freeboard of at least 30 mm.

NOTE — National regulations may require specific technical details concerning spillage.

5.1.7.13 Thermal breakdown of perc into toxic products

No heating system on the machine shall raise perc to a temperature at which it will break down into toxic products, e.g. for heating of still see 5.1.7.8 f).

5.1.8 Hazards due to neglect of ergonomic principles in machine design

This International Standard does not contain specific measures concerning the elimination or reduction of hazards due to neglect of ergonomic principles in machine design.

The height of the loading and unloading doors should conform with EN 614-1:1995, annex A.

5.2 Hazards associated with phases of "life" of a machine other than use

The safety requirements given in this International Standard apply to the use of the machine. For the other phases of "life" of a machine, such as

a) transport and commissioning:

- assembly, installation
- adjustment

b) decommissioning, dismantling and, as far as safety is concerned, disposal,

safety measures should be selected in accordance with ISO/TR 12100-1:1992, clause 5, and information concerning machine use should be given in accordance with ISO/TR 12100-2:1992, 5.5.1 a), b) and f).

6 Verification of safety requirements and/or measures

Table 4 gives a reference and/or method of check for all requirements in clauses 5 and 7.

Table 4 — List of verification

Subclause	Subject	Reference	Test method
5.1.1.1	Moving drive components Guards	table 1	Inspection and testing, measurement
5.1.1.2	Rotating cage Access through doors Door interlock with guard locking Category of control system	ISO 14119 EN 954-1	Visual inspection Check function Check manufacturer's technical file
5.1.1.3	Ejection of machine parts Maximum force Tangential stress	ISO 6178	Check manufacturer's technical file Calculation
5.1.2	Electrical hazards Category of control system Emergency stop Lockable shut-down	table 2 ISO 13849-1 ISO 13850 EN 1037	Visual inspection and check manufacturer's technical file Check manufacturer's technical file Check presence and function Check presence and function
5.1.3	Failure of services Door remains locked Door can be opened by tool Valve return to safe position Restarting Cooling water flow Pneumatic system	EN 983	Switch off and try Open door with tool Switch off each service in turn, visual inspection Stop and restart each service in turn Check function
5.1.4.1	Hot surfaces Surface temperature Protection Labelling	Instruction handbook	Measurement Visual inspection, measurement Visual inspection, confirm accuracy and content

Table 4 — (continued)

Subclause	Subject	Reference	Test method
5.1.4.2	Steam heating Valve Pipes	Instruction handbook	Confirm accuracy and content Visual inspection
5.1.4.3	Thermal fluid at atmospheric pressure Thermostatic heating regulator Temperature limit Temperature sensor, alarm Expansion vessel on the heating chamber Level of thermal fluid Automatic valve Vent cleaning	 Instruction handbook	 Inspect control wiring Compare temperatures Check presence and function Heat up and check Visual inspection Switch off heating Confirm accuracy and content
5.1.4.4	Pressurized fluids Flexible or fragile parts		Visual inspection
5.1.6	Vibration		Calculation and evaluation
5.1.7	Perc Interlocking device for room ventilation		Check function
5.1.7.1	Opening of the loading door Interlocking with guard locking	ISO 14119:—, 5.3, 5.4	Check function and manufacturer's technical file

Table 4 — (continued)

Subclause	Subject	Reference	Test method
5.1.7.2	Evaporation of perc from work Control of drying Control of deodorisation Door locking Door opening after irregular stop Service failure Means for measurement of concentration Load labelling	Instruction handbook Instruction handbook	Check function, measurement Check function, measurement Check function Check procedure Switch off coolant and check function Visual inspection and test Visual inspection, confirm accuracy and content
5.1.7.3	Water separator Sealed collecting tank, connection and capacity Sight glass Labelling of tank Draining instruction Drainage of water separator, valves	Instruction handbook Instruction handbook	Visual inspection and evaluation Visual inspection Visual inspection, confirm accuracy and content Confirm accuracy and content Visual inspection and check function
5.1.7.4	Rotating joints, etc.		Check materials and manufacturer's technical file
5.1.7.5	Lint filter Labelling Interlock Category	Instruction handbook ISO 14119:—, 5.3, 5.4 ISO 13849-1	Visual inspection, confirm accuracy and content Check function Check manufacturer's technical file
5.1.7.6	Button trap as in 5.1.7.5 of this table Prevent overflow		Check function

Table 4 — (continued)

Subclause	Subject	Reference	Test method
5.1.7.7	Solvent filter Open with tool only Avoid spillage Filter venting Pressure gauge		Check function Visual inspection Visual inspection Visual inspection
5.1.7.8	Distilling installation a) Chamber, chimney and condenser access for cleaning Chimney diameter b) Pressure-relief valve c) Pressure-relief device Test method Heat cut-off d) Overfilling control e) Door interlock Category f) Still heating surface g) Air or steam injection valves h) Lack of coolant Condensate temperature i) Manual drain valve j) Sight glass and light Level marking k) Opening of access door l) Evacuation into lidded container; connection for residues m) Cleaning instruction label	Table 3 Instruction handbook Instruction handbook ISO 14119:—, 5.3, 5.4 ISO 13849-1 Instruction handbook	Visual inspection and evaluation Measurement Confirm accuracy and content Confirm accuracy and content Function test Check function Check function Check function Check manufacturer's technical file Measurement Switch off air or steam injection and check function Check function Measurement Check function Visual inspection and evaluation Visual inspection Check function Visual inspection Visual inspection, confirm accuracy and content

Table 4 — (concluded)

Subclause	Subject	Reference	Test method
5.1.7.9	Filling or topping up tanks Interconnection of tanks Level indicator Tank filling via pumps		Visual inspection Visual and physical inspection Check function
5.1.7.10	Faulty operation Simultaneous manual and automatic control Access by inspection doors Solvent level display	ISO/TR 12100-1:1992, A.1.2.5	Check function Physical inspection Visual inspection
5.1.7.11	Cooling failure in the drying system Coolant flow sensor Cycle stop, warning signal		Visual and physical inspection, check manufacturer's technical file Check function
5.1.7.12	Spillage tank Strength and capacity		Measurement and evaluation, check manufacturer's technical file
5.1.7.13	Breakdown of perc	5.1.7.8 f)	Measurement
5.1.8	Height of door	annex A	Measurement
5.2	Phases of "life"	ISO/TR 12100-1 ISO/TR 12100-2	
7.2	Machine plate	ISO/TR 12100-2:1992, 5.4	Visual inspection
7.3	Warning notice	ISO/TR 12100-2:1992, 5.4	Visual inspection
7.4 and 7.5	Instruction handbook	ISO/TR 12100-2:1992, 5.5	Check completeness

7 Information concerning machine use

7.1 General

Each machine shall be provided with sufficient information to enable efficient and safe operation. The information for machine use will usually comprise three types:

- a) a machine plate carrying essential data for that machine (see 7.2);
- b) other warning notices has be placed on the machine (see 7.3), for example to indicate the hazards of perc and action to be taken in the event of an emergency, e.g. spillage of perc;
- c) instruction handbook containing details of how to install and operate the machine in a safe manner, with description of how the machine works (see 7.4 and 7.5).

7.2 Machine plate

A clearly visible machine plate shall indicate legibly all relevant data in accordance with ISO/TR 12100-2:1992, 5.4.

Additional information, specific to dry-cleaning machines, shall be included, particularly the whole perc capacity of the dry-cleaning machine.

In case of modular dry-cleaning machines, each module, i.e. washing unit (tank, drum, tunnel), still unit (tank, still, filter, separate control panel) shall be separately identified and shall have its own machine plate.

The machine plate shall be permanently fixed to the dry-cleaning machine and its durability shall match the life of the machine. An example of a typical layout of the minimum information needed is given in table 5.

Any graphical symbols shall be in accordance with ISO 5232.

Table 5 — Example of machine plate

Manufacturer:	
Address:	
Type:	Serial number:
Year of manufacture:	
Maximum dry load:..... kg	
Perc capacity:	l
Electrical supply:	V phases:..... Hz
Maximum power:..... kW	
Maximum current:	A
Maximum steam pressure:..... bar	(..... MPa)
Water pressure:..... bar	(..... MPa)
Compressed air pressure:..... bar	(..... MPa)
IMPORTANT: Refer to the instruction handbook for maintenance and operation.	

7.3 Warning notices

A general warning notice of durable construction shall be fixed to the machine in a position where it can be clearly seen by the machine operator, detailing the hazards of perc and the procedures to be followed in the event of a spillage or inhalation of perc vapour.

Other warning notices may be required on any vessel that may contain perc that could inadvertently be removed from the machine and cause hazard, e.g. the vessel used to collect water from the water separator could cause an effluent hazard if disposed of incorrectly.

7.4 Instruction handbook

The manufacturer shall provide an instruction handbook as described in ISO/TR 12100-2:1992, 5.5.

The manufacturer shall provide information on noise emission in accordance with ISO/TR 12100-2:1992, A.1.7.4.

The manufacturer shall provide information required by EN 60204-1:1992, clause 19.

In addition the instruction handbook shall contain three types of information:

- a reproduction of the content of the machine plate and warning notices so that if these are lost or damaged they can be replaced correctly;
- information explaining how the machine is designed to operate, the hazards (especially from perc), and the safety features which minimize the risk of these hazards;
- instructions for safe achievement of the following:
 - ♦ installation
 - ♦ operator training
 - ♦ operation and operator maintenance *
 - ♦ action to be taken in an emergency *
 - ♦ engineer training
 - ♦ engineering maintenance *
 - ♦ safety monitoring *

NOTES

- 1 The sections marked * should be written as step-by-step procedures that can be used for training.
- 2 The information explaining how the machine is designed to operate, the hazards and the safety features should be written simply and without jargon to be suitable to be handed out after training to operators and engineers.

7.5 Special points of information and instructions

Perc dry-cleaning machines involve some hazards that are very specific to this type of equipment and which need particular mention in the instruction handbook. Table 6 is not exhaustive but it is intended to prompt inclusion of these and related points.