BRITISH STANDARD

BS EN 982:1996 +A1:2008

Safety of machinery — Safety requirements for fluid power systems and their components — Hydraulics

ICS 13.110; 23.100.01

National foreword

This British Standard is the UK implementation of EN 982:1996+A1:2008. It supersedes BS EN 982:1996 which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to CEN text carry the number of the CEN amendment. For example, text altered by CEN amendment A1 is indicated by [A1] ⟨A1⟩.

The UK participation in its preparation was entrusted to Technical Committee MCE/3, Safeguarding machinery.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

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English Version

Safety of machinery - Safety requirements for fluid power systems and their components - Hydraulics

Sécurité des machines - Prescriptions de sécurité relative aux systèmes et leurs composants de transmissions hydrauliques et pneumatiques - Hydraulique

Sicherheit von Maschinen - Sicherheitstechnische Anforderungen an fluidtechnische Anlagen und deren Bauteile - Hydraulik

This European Standard was approved by CEN on 11 March 1996 and includes Amendment 1 approved by CEN on 27 July 2008.

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

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

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Foreword

This document (EN 982:1996+A1:2008) has been prepared by Technical Committee CEN/TC 114 “Safety of machinery”, the secretariat of which is held by DIN.

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 March 2009, and conflicting standards shall be withdrawn at the latest by December 2009.

This document includes Amendment 1, approved by CEN on 2008-07-27.

This document supersedes EN 982:1996.

The start and finish of text introduced or altered by amendment is indicated in the text by tags ⟩A1⟨ ⟨A1⟩.

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

⟩A1⟨ For relationship with EU Directive(s), see informative Annexes ZA and ZB, which are integral parts of this document. ⟨A1⟩

It was developed to contribute towards unification of safety regulations and procedures in the various member countries for each aspect dealt within the field of hydraulics for fluid power systems and their components. This Standard utilizes the most recently validated technical information from established technical sources (e.g. CEN, ISO, national standards and European documents).

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

Introduction

This standard is a type B2 standard (according to EN 292-1) and contains the general requirements for hydraulic systems and their components on machinery. For type C standard makers, it is a basis for the development of specific requirements on dedicated machines. If no type C standards are available, it is a basis for the manufacturers when constructing machines that include hydraulic systems and their components.

In developing this standard, safety related requirements out of ISO 4413 were selected as well as additional safety related requirements.

Equivalent safety requirements for pneumatic systems are defined in EN 983 "Safety of machinery – Safety requirements for fluid power systems and their components – Pneumatics".

1 Scope

This standard applies to hydraulic systems and their components on machinery. It identifies hazards and factors which affect the safety of systems and their components when they are put to their intended use.

The principles specified apply to the design, construction and modification of new systems and their components and aspects of use including:

— Assembly

— Installation

— Adjustment

— Operation

— Cleaning

— Maintenance.

Components are covered in the standard but only to the extent that safety requirements are given to allow the components to be safely integrated into a system's design.

The standard applies to systems and their components on machinery that are manufactured after the date of the adoption of this standard.

2 Normative references

This European Standard incorporates by dated or undated reference, 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.*

EN 418, *Safety of machinery – Emergency stop equipment, functional aspects – Principles for design.*

EN 563, *Safety of machinery – Temperature of touchable surfaces – Ergonomic data to establish temperature limit values for hot surfaces.*

prEN 954-1:1992, *Safety of machinery - Safety related parts of control systems — Part 1: General principles for design.*

prEN 1050:1992, *Safety of machinery - Risk assessment*

ENV 1070, *Safety of machinery – Terminology.*

prEN 1127-1:1993, *Safety of machinery – Fire and explosions – Part 1: Explosion prevention and protection.*

EN 50081-2, *Electromagnetic compatibility – Generic emission standard – Part 2: Industrial environment.*

prEN 50082-2:1994, *Electromagnetic compatibility – Generic immunity standard – Part 2: Industrial environment.*

EN 60204-1:1992, *Safety of machinery - Electrical equipment of machines – Part 1: General requirements (IEC 204-1:1992, modified).*

EN 60529, *Degrees of protection provided by enclosures (IP code) (IEC 529:1989).*

ISO 1219-1, *Fluid power systems and components – Graphic symbols and circuit diagrams – Part 1: Graphic symbols.*

ISO/DIS 1219-2:1993, *Fluid power systems and components – Graphic symbols and circuit diagrams – Part 2: Circuit diagrams.*

ISO 4021, *Hydraulic fluid power – Particulate contamination analysis – Extraction of fluid samples from lines of an operating system*.

ISO 5598, *Fluid power systems and components - Vocabulary*.

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

3 Definitions

For the purposes of this standard, the definitions of ENV 1070 and the following apply. Other definitions not included are given in ISO 5598.

3.1
fluid power
the means whereby signals and energy can be transmitted, controlled and distributed using a pressurized fluid as the medium

3.2
system
arrangement of interconnected components which transmits and controls fluid power energy

3.3
component
an individual unit (e.g. cylinder, motor, valve, filter) comprising one or more parts designed to be a functional part of a fluid power system

3.4
hydraulics
science and technology which deals with the use of a liquid as the fluid power medium

3.5
maximum working pressure
the highest pressure at which the system or part of the system is intended to operate in steady-state conditions

3.6
rated pressure
the highest pressure at which the component is intended to operate for a number of repetitions sufficient to assure adequate service life

3.7
operating device
device that provides an input signal to a control mechanism (e.g. cam, switch)

3.8
control mechanism
a device that provides an input signal to a component (e.g. lever, solenoid)

3.9
actuator
component that transforms fluid energy into mechanical energy (e.g. motor, cylinder)

3.10
piping
any combination of fittings, couplings or connectors with pipes, hoses or tubes which allows fluid flow between components

4 List of hazards

The possible hazards associated with the use hydraulic power in a machine are given in table 1:

Table 1 — List of hazards

Hazard type	Relevant clauses			Relevant type B standard or clause in this standard
	EN 292-1:1991	EN 292-2:1991	Annex A of EN 292-2:1991	
4.1 Mechanical hazards — shape — relative location — mass and stability (potential energy of elements) — mass and velocity (kinetic energy of elements) — inadequacy of the mechanical strength — accumulation of potential energy by: — elastic elements (springs), or — liquids or gases under pressure, or — vacuum — leakage	4.2		1.3, 1.4, 1.3.7	5.1.1, 5.1.2, 5.1.3, 5.1.5, 5.1.7, 5.2.1, 5.2.2, 5.2.3, 5.3.1, 5.3.2, 5.3.3, 5.3.4.2, 5.3.4.3, 5.3.4.4, 5.3.4.5, 7.2, 7.3.1
4.2 Electrical hazards				5.1.6, 5.2.1, 5.3.3.3.2 a, EN 60204-1
4.3 Thermal hazards resulting in burns and scalds, by a possible contact of persons, by flames or explosions and also by the radiation of heat sources				5.1.9, 5.1.10, 5.2.1, 5.3.4.6
4.4 Hazards generated by noise				5.1.8, 5.2.1
4.5 Hazards, especially unintended movements, caused by electromagnetic fields		3.7.11	1.5.10, 1.5.11	EN 50081-2, prEN 50082-2
4.6 Hazards generated by materials and substances processed, used and exhausted by machinery			1.5.13	
4.6.1 Hazards resulting from contact with or inhalation of harmful fluids, gases, mists, fumes and dusts				5.3.2.6, 7.1, 7.2
4.6.2 Fire or explosion hazards				5.2.1, 5.3.4.1

continued

Table 1 — (concluded)

Hazard type	Relevant clauses			Relevant type B standard or clause in this standard
	EN 292-1:1991	EN 292-2:1991	Annex A of EN 292-2:1991	
4.7 Hazards caused by failure of energy supply, breaking down of machinery parts and other functional disorders	5.2.2	3	1.2	
4.7.1 Failure of energy supply (of energy and/or control circuits) — variation of energy — unexpected start — prevention from stopping if the command has already been given — falling or ejecting of moving parts or pieces held by the machinery — impeded automatic or manual stopping — protection device remains not fully effective	3.16	3.7	1.2.6	5.1.4, 5.1.6, 5.2.1, 5.3.3.3.2 c, 5.3.3.3.2 d
4.7.2 Unexpected ejection of machine parts or fluids	4.2.1	3.8, 4	1.3.2, 1.3.3	5.2.1, 5.3.4.3.2
4.7.3 Failure, malfunction of control system (unexpected start up, unexpected overrun)	3.15, 3.16, 3.17	3.7	1.2.7, 1.6.3	prEN 954-1, 5.1.4, 5.1.6, 5.3.3.2, 5.3.5, 5.3.6, 5.3.7
4.7.4 Errors of fitting			1.5.4	5.2.1, 5.2.2, 5.2.3, 5.3.3.1, 5.3.4.2, 5.3.4.3, 5.3.4.5.3, 7.3
4.8 Hazards caused by temporarily missing and/or incorrectly positioned safety related measures/means, for example		4		
4.8.1 Starting and stopping devices		3.7	1.2.3, 1.2.4	5.1.4
4.8.2 Safety signs and signals		3.6.7, 5.2, 5.3, 5.4	1.7.2, 1.7.3	5.3.4.5.1, 7.2
4.8.3 All kinds of information or warning devices		5.4	1.7.0, 1.7.1	5.3.4.1.3, 5.3.4.4.2, 5.3.5.7, 7.3
4.8.4 Energy supply disconnecting devices		6.2.2	1.6.3	5.1.6, 5.3.4.5.2, 7.2
4.8.5 Emergency devices		6.1	1.2.4	EN 418
4.8.6 Essential equipment and accessories for safe adjusting and /or maintaining	3.3, 3.11	3.12, 6.2.1, 6.2.3, 6.2.6	1.1.2 f, 1.1.5	5.1.5, 5.3.2.3, 5.3.4.1.3, 5.3.5.1, 5.3.5.2

5 Safety requirements and/or measures

When designing hydraulic systems for machinery, all intended operations and use of systems shall be considered. Risk assessment in accordance with prEN 1050 shall be carried out to determine the foreseeable risks associated with systems when they are used as intended by their design. So far as it is practicable, the risks identified shall be eliminated by design and, where this is not practicable, the design shall incorporate safeguards against such risks. See EN 292-2.

Where systems or parts of systems have safety related control functions, they should be designed and constructed to meet specified categories of performance, as given in prEN 954-1.

5.1 Basic requirements for the design and specification of hydraulic systems

5.1.1 All components in the system shall be selected or specified to provide for safety in use, and they shall operate within their design limits when the system is put to its intended use. Components shall be selected or specified so that they have adequate characteristics to allow them to operate reliably under all intended uses of the system. Particular attention shall be paid to the reliability of components that could create a hazard in the event of their failure or malfunction.

The components shall be selected, applied and installed in accordance with the manufacturer's recommendations.

NOTE It is recommended that, wherever practicable, components should be made in conformance with recognised international or national standards.

5.1.2 All parts of the system shall be designed or otherwise protected against pressures exceeding the maximum working pressure of a system or any part of the system or the rated pressure of any specific component.

The preferred means of protection against excessive pressure are one or more pressure relief valves located to limit the pressure in all parts of the system. Alternative means, such as pressure compensator pump controls, may be used, provided those means satisfy the application requirements.

Systems shall be designed, constructed and adjusted to minimize surge pressures and intensification pressures. Surge pressure and intensified pressure shall not cause hazards.

Loss of pressure or critical drops in pressure shall not expose persons to a hazard.

5.1.3 Leakage (internal or external) shall not cause a hazard

5.1.4 Whatever the type of control or power supply used (e.g. electrical, hydraulic, etc.) the following actions or occurrences (unexpected or by intention) shall not create a hazard:

— Switching the supply on or off;

— Supply reduction;

— Supply cut-off or re-establishment.

5.1.5 The system shall be designed and constructed so that components are located where they are accessible and can be safely adjusted and serviced.

5.1.6 The system shall be designed to facilitate positive isolation from energy sources and also to facilitate dissipation of the fluid pressure in the system in order to prevent unexpected start-up. In hydraulic systems this can be done by e.g.

— Mechanical locking of isolation valves to the shut-off position, and

— Dissipation of pressure from hydraulic systems;

— Isolation of the electrical supply (see 5.3 of EN 60204-1:1992).

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

5.1.8 For the design of low-noise machinery and systems, see ISO/TR 11688-1.

5.1.9 The full range of operating temperatures for the system or component shall be specified. The fluid temperature shall not exceed those specified limits at which it can safely be used or the specified working range of any component in the system.

5.1.10 Hydraulic systems shall be designed to protect personnel from surface temperatures that exceed touchable limits by either siting or guarding (see EN 563).

5.2 Additional requirements

5.2.1 Site conditions

When designing systems, it shall be ensured that the following influences that can lead to a hazard are considered:

— Vibration, contamination, humidity, range of ambient temperatures;

— Fire or explosion hazard (see prEN 1127-1);

— Electrical network (voltage and its tolerances, frequency, available power);

— Protection for electrical devices;

— Requirements for guarding;

— Legal and other environmental limiting factors (e.g. noise emission level);

— Space required for access, use and maintenance, as well as the location and mounting of components and systems to ensure their stability and security in use;

— Available cooling and heating capacity and media;

— Other safety requirements.

5.2.2 Component removal

To facilitate maintenance, means shall be provided or components so fitted that their removal from the system for maintenance:

— Should minimise the loss of fluid;

— Should not require draining of the reservoir;

— Should not necessitate extensive disassembly of adjacent parts.

5.2.3 Preparation for transportation

5.2.3.1 Identification of piping

Whenever systems have to be dismantled for transportation, the piping and connections shall be clearly identified. The identification shall correspond and not conflict with the data on any appropriate drawings.

5.2.3.2 Packaging

All systems/components shall be packaged in a manner that protects them from damage and distortion and preserves their identification during transportation.

5.2.3.3 Sealing of openings

Exposed openings in hydraulic systems/components shall be sealed, and male threads shall be protected during transportation. These seals shall only be removed immediately before reassembly. Only sealing caps that require their removal before reassembly can take place shall be used.

5.3 Specific requirements for components and controls

5.3.1 Pumps and motors

5.3.1.1 Working pressure range

If there are any restrictions on the working pressure range at which a pump or motor may be used, these shall be defined in the information for use (see 7).

5.3.1.2 Couplings and mountings

Driving couplings and mountings shall be capable of continuously withstanding the maximum torque that may be generated at the pump or motor under all conditions of intended use.

Drive couplings shall be suitably guarded.

5.3.1.3 Speed

Speed shall not exceed the maximum, as specified in the manufacturer's documentation.

5.3.1.4 Drains, air bleeds and auxiliary ports

Drains, air bleeds, etc., shall be so installed that they do not allow ingress of air into the system and shall be so dimensioned and installed that no excessive back pressure will be generated. High pressure air bleeds shall be installed so as to minimize the hazard to the personnel.

5.3.2 Cylinders

5.3.2.1 Resistance to buckling

Attention shall be given to stroke length, loading and cylinder mountings in order to avoid bending or buckling of the cylinder piston rod at any position.

5.3.2.2 Resistance to shocks and vibrations

Any components mounted on or connected to a cylinder shall be attached in a way that resists loosening caused by shocks, vibrations, etc.

5.3.2.3 Stroke end stops

If stroke length is determined by external stroke end stops, means shall be provided for locking adjustable end stops.

5.3.2.4 Alignment

Mounting surfaces shall be designed to prevent distortion of the cylinder when installed. The cylinder shall be mounted in a way that avoids unintended side loads during operation.

5.3.2.5 Mounting fasteners

Mounting fasteners for cylinders and attachments shall be designed and installed to accommodate all predictable forces. As far as possible the fasteners should be free from shear forces. Foot-mounted cylinders should have means to absorb shear loads, rather than depending on mounting fasteners. The mounting fasteners shall be adequate to absorb overturning moments.

5.3.2.6 Air vent

Single acting piston type cylinders shall have their air vent port designed and/or positioned to avoid hazards to persons when entrapped fluid is ejected.

5.3.2.7 Rod protection

Piston rods should be protected against foreseeable damage from dents, scratches, corrosive fluids, etc.

5.3.2.8 Air bleeds

Cylinders shall be self-bleeding or accessible external air bleeds shall be provided.

5.3.3 Valves

5.3.3.1 Mounting

5.3.3.1.1 Method

Valve type and method of mounting shall be selected to ensure correct function, adequate leak tightness and resistance against foreseeable mechanical and/or environmental influence.

5.3.3.1.2 Orientation

There shall be means to avoid incorrect mounting of valves.

5.3.3.1.3 Attitude

The effects of gravity, impact or vibration on the main elements of a valve shall be considered when mounting any valve.

5.3.3.2 Spring biased or detent located valves

Any actuator required to maintain its position or to adopt a specific position for safety, in the event of a control system failure, shall be controlled by a valve which is either spring biased or detent located to a safe position.

5.3.3.3 Valve operating devices

5.3.3.3.1 Mechanically operated valves

Mechanically operated valves shall be installed so that they cannot be damaged by the operating device.

5.3.3.3.2 Electrically operated valves

a) Electrical connections

Electrical connections to a supply shall be in accordance with appropriate standards, e.g. EN 60204-1. For hazardous operation conditions, the appropriate degree of protection (e.g. explosion proofing, water proofing) shall be employed.

b) Terminal block housing

Where terminal blocks and housings are specified on the valves, the terminal block housing shall be constructed as follows:

- The appropriate degree of protection in accordance with EN 60529;
- Adequate space for permanently located terminals and for the terminal cable including an additional length of cable;
- Captive fasteners for the electrical access cover to prevent loss, e.g. screws with retaining washer;
- Suitable securing device for the electrical access cover; e.g. a chain;
- Cable connections with strain relief.

c) Solenoids

Solenoids shall be sized so that they are capable of operating the valves reliably at the nominal voltage $\pm$ 10%.

Solenoids shall be protected against the entry of extraneous fluid or dirt in accordance with EN 60529.

d) Manual override

If an electrically operated valve needs to be operated for safety reasons when electrical control is not available, then it should be fitted with manual override facilities. These shall be designed so that they cannot be operated inadvertently and they should reset when the manual control is removed unless otherwise specified.

5.3.4 Energy transmission and conditioning

5.3.4.1 Fluids

5.3.4.1.1 Specification

The fluid recommended for use in a system shall be defined by type and characteristics and not solely by manufacturer's trade name.

Where a fire hazard exists, consideration shall be given to the use of a fire-resistant fluid (see 5.2.1).

5.3.4.1.2 Compatibility

All hydraulic fluids used shall be compatible with all components, elastomers, seals, packings, and filter elements used in the system and be in accordance with the recommendations of the system/component manufacturers.

Additional precautions shall be taken to prevent problems due to incompatibility of certain fire-resistant fluid with

— Protective finishes and other fluids associated with the system, for example, paints, process and/or service fluids;

— Construction and installation material that can be in contact with spilled or leaking fire-resistant fluid, for example electrical cabling, other service supplies and products;

— Other fluids.

5.3.4.1.3 Contamination control

Systems shall have a means of controlling the fluid cleanliness level to ensure safe operation of the system and its components.

Means should be provided to show when a filter or separator requires servicing.

If blocking of a filter could lead to a hazardous situation, clear indication of such blockage shall be given.

A means of obtaining a representative fluid sample per ISO 4021 should be provided to allow for checking fluid cleanliness condition. If a sample valve is provided from a high pressure line, a label warning of a high pressure jet hazard shall be installed and the sample valve shall be shielded.

5.3.4.2 Pipes, fittings and fluid passages

5.3.4.2.1 Design of layout

Piping should be designed to discourage its use as a step or ladder. External loads should not be imposed upon piping.

5.3.4.2.2 Piping location

To avoid incorrect connections which might cause a hazard, pipes should be identified and located accordingly.

Piping, both rigid and flexible, shall be located to protect against foreseeable damage and not restrict access for adjustment, repairs, replacement of components or work in process.

5.3.4.2.3 Foreign matter

Pipes, fittings and fluid passages, including cored and drilled holes, shall be free of detrimental foreign matter such as scale, burrs, swarf, etc, that may restrict flow or be dislodged and cause malfunction of and/or damage to any component including seals and packings.

5.3.4.2.4 Supports

If necessary piping shall be securely supported both at its ends and at intervals along its length by correctly designed supports.

Pipe supports shall not damage the pipe.

Piping shall not be used to support components where they would impose undue loads on the piping. Undue loads may arise from component mass, shock, vibration and surge pressure.

5.3.4.2.5 Quick action (release) couplings

Quick action (release) couplings shall be selected to automatically seal the fluid pressure on the upstream side and on the downstream side so as to prevent a hazard when the adaptor is removed.

5.3.4.3 Flexible hose assemblies

Flexible hose assemblies shall not be constructed from hoses which have been previously used as part of a hose assembly. Flexible hose assemblies shall fulfil all performance requirements specified in the appropriate European and/or International standard(s).

Recommendations on storage time for the flexible hose assemblies given by the hose manufacturers shall be considered.

Consideration should be given to recommending a service life for hose assemblies.

5.3.4.3.1 Installation

Installation of flexible hose assemblies shall

— Have the minimum length necessary to avoid sharp flexing and straining of the hose during the component operation. Flexible hoses should not be bent with a radius smaller than the recommended minimum bending radius;

— Minimise torsional deflection of the hose during the installation and use, e.g. as a result of a rotating connector jamming;

— Be located or protected to minimise abrasive rubbing of the hose cover;

— Be supported, if the weight of the hose assembly could cause undue strain.

5.3.4.3.2 Failure

If the failure of a flexible hose assembly constitutes a whiplash hazard, it shall be restrained or shielded.

If the failure of a flexible hose assembly constitutes a fluid ejection hazard, it shall be shielded.

5.3.4.4 Fluid reservoirs

5.3.4.4.1 Design

The design of the reservoir is to be such that

— It shall adequately dissipate heat from the fluid under all normal working conditions in particular when heat exchangers are not installed in the system;

— It should contain all the fluid that can flow from the system under normal operation or maintenance conditions;

— It shall maintain the fluid level at a safe working height and allow sufficient fluid access to supply lines during all operating cycles and operating attitudes, and allow adequate space for thermal expansion and air separation.

If the fluid reservoir is of the pressurised type then the special requirements of that type of unit shall be considered.

5.3.4.4.2 Accessories

Indicators showing the fluid level shall be permanently marked with system "high" and "low" levels. Provisions should be made for additional marks as appropriate to specific systems (e.g. 'hot', 'engine running', 'boom extended', etc.).

Filling points should be fitted with sealed covers to prevent the ingress of contaminants when closed.

Air breathers on vented reservoirs should be provided which filter air entering the reservoir to a cleanliness level compatible with the system requirements, taking into consideration the environmental conditions in which the system is to be installed.

5.3.4.5 Gas-loaded accumulators

5.3.4.5.1 Identification

In addition to the requirements of 7.3.1, the following identification shall be permanently marked on the accumulator:

— Date of manufacture (month/year);

— Manufacturer's serial number;

— Total shell volume in litres;

— Allowable temperature range in degrees Celsius.

The following identification shall be given on the accumulator or on a label on the accumulator:

— "Caution - Pressurized vessel. Discharge prior to disassembly.";

— Gas pre-charge pressure;

— "Use only ……." (pre-charge medium, e.g. nitrogen).

5.3.4.5.2 Hydraulic system requirements

Hydraulic systems incorporating gas-loaded accumulators shall automatically vent the accumulator liquid pressure or positively isolate (see 5.1.6) the accumulator when the system is shut-off.

In special situations where pressure is required after the machine is shut down, the above requirements need not be fulfilled.

The gas-loaded accumulator and any associated pressurized components shall be applied within the rated limits of pressure, temperature and environmental conditions. Protection against excessive pressure on the gas side may be required in special circumstances.

5.3.4.5.3 Installation

a) Mounting position

If damage to components and fittings in an accumulator system could cause a hazard, they shall be suitably protected.

b) Support

The gas-loaded accumulator and any associated pressurized components shall be supported according to the manufacturer's instructions.

c) Unauthorised alterations

It is forbidden to modify a gas-loaded accumulator by machining, welding or any other means.

5.3.4.5.4 Maintenance

a) Gas pre-charge

The main routine service likely to be required on a gas-loaded accumulator is to check/adjust the gas pre-charge pressure. Only apparatus and procedures recommended by the manufacturer for gas pre-charging of accumulators shall be used. The charging medium shall be nitrogen or other suitable gas.

Pressure checks shall be carried out by the method recommended by the accumulator manufacturer. Care shall be taken not to exceed the maximum allowable pressure of the accumulator.

After any check or adjustment there shall be no leakage of gas.

b) Removal from system

Before removal of gas-loaded accumulators for servicing the liquid pressure in the accumulator shall be reduced to zero.

5.3.4.6 Heat exchangers

Temperature measurement points should be available, if necessary, for both hydraulic fluid and cooling media.

Measuring points should include provisions for permanent installation of sensors and for service without loss of fluid.

5.3.5 System protection

5.3.5.1 Tamper-resistant protection

Pressure and flow control devices or their enclosures shall be fitted with tamper-resistant devices where an unauthorised alteration to pressure or flow can cause a hazard.

5.3.5.2 Adjustable control mechanisms

Adjustable control mechanisms shall hold their settings within specified limits until reset.

5.3.5.3 Control of multiple devices

Where there is more than one interrelated automatically and/or manually controlled device on the equipment, and where failure of any of these devices could cause a hazard, protective interlocks or other safety means shall be provided. Where practical, these interlocks should interrupt all operations, provided that such interruption does not of itself cause a hazard.

5.3.5.4 Protection under external loads

Means shall be provided to prevent unacceptable pressure build-up where high external loads are reflected on actuators.

5.3.5.5 Unintended movement

Control systems shall be designed to prevent unintended hazardous movement and improper sequencing of actuators. This applies to all phases of the operation.

5.3.5.6 Control system stability

Pressure and flow control valves shall be selected so that changes in working pressure, working temperature and load do not influence the operation in a hazardous way.

5.3.5.7 Monitoring of system parameters

Where changes in system operating parameters could constitute a hazard, clear indication shall be provided.

5.3.5.8 Fluid loss prevention

Means shall be provided to prevent the system fluid from draining back into the reservoir when the system is switched off, if such drainage could cause a hazard.

5.3.6 Sequence control

Sequencing by position sensing shall be used wherever practicable and shall always be used when a sequencing malfunction of a pressure or time lapse control, on its own, could cause a hazard.

5.3.7 Control systems with servo or proportional valves

5.3.7.1 Filter

A full flow filter without bypass and with a readily visible element condition indicator should be installed in the supply line and close to a servo or proportional valve if a valve malfunction caused by contaminant could create a hazard. The collapse strength of the filter element shall exceed the system maximum working pressure. Blockage of fluid flow by non-bypass filters shall not create a hazard.

5.3.7.2 System cleaning

The system and fluid should be cleaned to achieve a stabilised contamination level within the manufacturer specifications before servo and/or proportional valves are installed.

5.3.7.3 Override systems

Where actuators are controlled by servo or proportional valves and malfunction of the control system may result in the actuators causing a hazard then means shall be provided to maintain or recover control of these actuators.

5.3.7.4 Additional devices

Actuators, speed controlled by servo or proportional valves, shall have means to hold or move the actuator to a safe position if unintended movement may cause a hazard.

6 Verification of safety requirements and/or measures

Since a hydraulic system may not be a complete machine, many verification procedures cannot be carried out until the hydraulic system is incorporated into the machine. Appropriate instructions shall be given to the machine manufacturer by the hydraulic system designer/manufacturer.

6.1 Inspection

The systems and their components shall be verified by inspecting their identification in comparison to the system's specifications.

In addition the connection of components on the hydraulic system shall be inspected to verify its compliance with the circuit diagram.

6.2 Testing

The following tests shall be conducted to determine compliance with the applicable safety requirements:

— Operational tests to prove the correct operation of the system and all safety devices;

— Pressure test to test each part of the system at the maximum working pressure which may be sustained under all conditions of intended use.

No measurable unintended leakage shall be permitted other than slight wetting insufficient to form a drop.

7 Information for use

Information for use shall be in accordance with 5 of EN 292-2:1991.

7.1 Final data

A circuit diagram shall be provided. This diagram should be in accordance with ISO/DIS 1219-2.

Material safety data sheets of the fluid which is intended to be used, and advisory information on handling and disposal of the fluid shall be provided, including hygiene requirements for personnel when handling the fluid, and any toxic or asphyxiating hazard in the event of a fire.

7.2 Maintenance data

7.2.1 General maintenance data

All systems shall be provided with the necessary maintenance data which shall clearly:

— Indicate external lubrication points and the type of lubricant required and the intervals to be observed;

— Locate fluid level indicators, fill points, drains, filters, test points, strainers, magnets, etc., that require scheduled maintenance;

— Specify maximum allowable fluid contamination level;

— Give instructions for fluid maintenance, with particular regard to the water content of water-base fire resistant fluids;

— Provide advice for the safe handling of fluids and lubricants;

— Give any required depressurizing instructions and identify those parts of a system which are not depressurized by the normal venting device;

— Specify the cooling medium flow rate, maximum temperature, and permissible pressure range required for adequate cooling.

7.2.2 Accumulator maintenance data

A hydraulic system with an accumulator shall have a warning label "CAUTION – System contains accumulator(s). Depressurize system before maintenance."

If accumulator liquid pressure is required by design when the system is shut-off, complete information for safe servicing shall be referenced on or near the accumulator in a visible location.

Maintenance, overhaul and/or replacement of component parts shall only be carried out by suitably skilled personnel using instructions in accordance with A 1.7.4 b) of EN 292-2:1991.

Overhaul/re-certification for continued safe use of gas-loaded accumulators shall be carried out only by skilled personnel.

Before disassembly of a gas-loaded accumulator commences, it shall be fully depressurized on both liquid and gas sides.

7.3 Marking

7.3.1 Components

The following particulars shall be shown, if practicable, in a permanent and readily visible form on all components:

— The manufacturer's/supplier's name and brief address;

— The manufacturer's/supplier's product identification;

— The rated pressure;

— Symbols according to ISO 1219-1, and all ports correctly identified;

— For flexible hose assemblies: date of manufacture;

— For stacking modules: their order shall be clearly indicated adjacent to, but not on, the stack.

7.3.2 Components within a system

Each hydraulic component shall be allocated an item number and/or letter. This item number and/or letter shall be used to identify the component on all diagrams, lists and layouts. It should be clearly and permanently marked on the installation adjacent to the component.

7.3.3 Ports

Component ports, power take-off points (test ports and bleed points) and drain outlets (e.g. reservoir outlets) shall be clearly and distinctly identified. The identification shall correspond to the data on the circuit diagram.

7.3.4 Valve control mechanisms

7.3.4.1 Non-electrical control mechanisms

Valve control mechanisms and their functions shall be plainly and permanently identified with the same identification used on the circuit diagram.

7.3.4.2 Electrical control mechanisms

Electrical control mechanisms (solenoids and their attaching plugs or cables) shall be identified on the electrical and hydraulic circuit diagrams with the same identification.

7.3.5 Internal devices

Cartridge type valves and other functional devices (orifice plugs, passages, shuttle valves, check valves, etc.) located within a manifold, mounting plate, pad, or fitting, shall be identified adjacent to their access openings. Where access openings are located under a component or components, identification shall, if practicable, be provided adjacent to the component and marked "CONCEALED".

Annex A
(informative)

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European Standards

[1] EN 414, Safety of machinery; Rules for the drafting and presentation of safety standards.

[2] prEN 574:1991, Safety of machinery; Two-hand control device.

[3] EN 983, Safety of machinery; Safety requirements for fluid power systems and their components; Pneumatics.

[4] prEN 1037:1993, Safety of machinery; Isolation and energy dissipation; Prevention of unexpected start-up

[5] EN 50081-1, Electromagnetic compatibility (EMC); Generic emission standard; Part 1: Residential, commercial and light industry.

[6] prEN 50082-1:1994, Electromagnetic compatibility (EMC); Generic immunity standard; Part 1: Residential, commercial and light industry.

International Standards

[7] ISO 2230, Vulcanized rubber; Guide to storage.

[8] ISO 2719, Petroleum products and lubricants; Determination of flash point; Pensky-Martens closed cup method.

[9] ISO 2941, Hydraulic fluid power; Filter elements; Verification of collapse/burst resistance.

[10] ISO 2942, Hydraulic fluid power; Filter elements; Verification of fabrication integrity.

[11] ISO 2943, Hydraulic fluid power; Filter elements; Verification of material compatibility with fluid.

[12] ISO 2944, Fluid power systems and components; Nominal pressures.

[13] ISO 4400 Fluid power systems and components; Three-pin electrical plug connector; Characteristics and requirements.

[14] ISO 4406, Hydraulic fluid power; Fluids; Method for coding level of contamination by solid particles.

[15] ISO 4412-1, Hydraulic fluid power; Test code for determination of airborne noise levels; Part 1: Pumps.

[16] ISO 4412-2, Hydraulic fluid power; Test code for determination of airborne noise levels; Part 2: Motors.

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[18] ISO 4413, Hydraulic fluid power; General rules for the application of equipment to transmission and control systems.

[19] ISO 4572, Hydraulic fluid power; Filters; Multi-pass method for evaluating filtration performance.

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[21] ISO 6072, Hydraulic fluid power; Compatibility between elastomeric materials and fluids.

[22] ISO 6743-4, Lubricants, industrial oils and related products (class L); Classification; Part 4: Family H (Hydraulic systems).

[23] ISO 6952, Fluid power systems and components; Two-pin electrical plug connector with earth contact; Characteristics and requirements.

[24] ISO 7241-1, Hydraulic fluid power; Quick-action couplings; Part 1: Dimensions and requirements.

[25] ISO 7745, Hydraulic fluid power; Fire-resistant (FR) fluids; Guidelines for use.

[26] ISO 8331, Rubber and plastics hoses and hose assemblies; Guide to selection, storage, use and maintenance.

[27] ISO 10100, Hydraulic fluid power; Cylinders; Acceptance test.

CETOP[1)] – Recommendations

RP 18 H, Recommendations for starting, servicing and maintenance of accumulators.

RP 47 H, Recommendations for the safe application of gas loaded hydraulic accumulators.

RP 55 H, Schedule of the fire resistance tests for fire resistant fluid.

RP 64 H, Effect of evaporation of flammability for fire resistant fluid.

RP 65 H, Manifold ignition test for fire resistant fluid.

RP 66 H, Wick test for fire resistant fluid.

RP 91 H, Fluids for hydraulic transmissions; Mineral oils; Specifications.

RP 97 H, Fluids for hydraulic transmissions; Fire resistant fluids; Specifications.

RP 110 H, Fluids for hydraulic transmissions; Fire resistant fluids; Category HFA/E specifications

RP 117 H, Hydraulic fluid power; Flushing of hydraulic systems.

RP 118 H, Guidelines to contamination control in hydraulic fluid power systems.

1) CETOP: European Oil Hydraulic and Pneumatic Committee

Annex ZA
(informative)

A1 Relationship between this European Standard and the Essential Requirements of EU Directive 98/37/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive Machinery 98/37/EC, amended by 98/79/EC.

Once this standard is cited in the Official Journal of the European Communities under that Directive and has been implemented as a national standard in at least one Member State, compliance with the normative clauses of this standard confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard. A1

Annex ZB
(informative)

[A1] Relationship between this European Standard and the Essential Requirements of EU Directive 2006/42/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive Machinery 2006/42/EC.

Once this standard is cited in the Official Journal of the European Communities under that Directive and has been implemented as a national standard in at least one Member State, compliance with the normative clauses of this standard confers, within the limits of the scope of this standard, a presumption of conformity with the relevant Essential Requirements of that Directive and associated EFTA regulations.

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard. [A1]

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