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Hydraulic fluid power — General rules and safety requirements for systems and their components

*Transmissions hydrauliques — Règles générales et exigences de
sécurité relatives aux systèmes et leurs composants*



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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

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

ISO 4413 was prepared by Technical Committee ISO/TC 131, *Fluid power systems*, Subcommittee SC 9, *Installations and systems*.

This third edition cancels and replaces the second edition (ISO 4413:1998), which has been technically revised, specifically with regards to the following:

- a) integration of ISO 4413:1998 and EN 982:1996;
- b) integration of safety requirements to comply with the European Machinery Directive 2006/42/EC;
- c) updating of safety requirements, taking into account International Standards on machine safety.

Introduction

This International Standard is a type B standard as defined in ISO 12100. The provisions of this International Standard can be supplemented or modified by a type C standard. For machines that are covered by the scope of a type C standard and that have been designed and built in accordance with the provisions of that standard, the provisions of that type C standard take precedence over the provisions of this type B standard.

In hydraulic fluid power systems, power is transmitted and controlled through a liquid under pressure within an enclosed circuit.

In the past, ISO 4413 was intended to provide assistance in the understanding between the supplier and the purchaser. This edition of ISO 4413 now includes, in addition, general requirements for the engineering of a hydraulic system and safety requirements that support the essential health and safety requirements of the European Machinery Directive.

Equivalent requirements for pneumatic systems are defined in ISO 4414.

Hydraulic fluid power — General rules and safety requirements for systems and their components

1 Scope

This International Standard specifies general rules and safety requirements for hydraulic fluid power systems and components used on machinery as defined by ISO 12100:2010, 3.1. It deals with all significant hazards associated with hydraulic fluid power systems and specifies the principles to apply in order to avoid those hazards when the systems are put to their intended use.

NOTE 1 See Clause 4 and Annex A.

The significant hazard noise is incompletely dealt with in this International Standard.

NOTE 2 Noise emission depends especially on the installation of hydraulic components or systems into machinery.

This International Standard applies to the design, construction and modification of systems and their components, also taking into account the following aspects:

- a) assembly;
- b) installation;
- c) adjustment;
- d) uninterrupted system operation;
- e) ease and economy of maintenance and cleaning;
- f) reliable operation in all intended uses;
- g) energy efficiency; and
- h) environment.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1219-1, *Fluid power systems and components — Graphic symbols and circuit diagrams — Part 1: Graphic symbols for conventional use and data-processing applications*

ISO 1219-2, *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*

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ISO 4406, *Hydraulic fluid power — Fluids — Method for coding the level of contamination by solid particles*

ISO 5598, *Fluid power systems and components — Vocabulary*

ISO 6149-1, *Connections for hydraulic fluid power and general use — Ports and stud ends with ISO 261 metric threads and O-ring sealing — Part 1: Ports with truncated housing for O-ring seal*

ISO 6149-2, *Connections for hydraulic fluid power and general use — Ports and stud ends with ISO 261 metric threads and O-ring sealing — Part 2: Dimensions, design, test methods and requirements for heavy-duty (S series) stud ends*

ISO 6149-3, *Connections for hydraulic fluid power and general use — Ports and stud ends with ISO 261 metric threads and O-ring sealing — Part 3: Dimensions, design, test methods and requirements for light-duty (L series) stud ends*

ISO 6162-1, *Hydraulic fluid power — Flange connectors with split or one-piece flange clamps and metric or inch screws — Part 1: Flange connectors for use at pressures of 3,5 MPa (35 bar) to 35 MPa (350 bar), DN 13 to DN 127*

ISO 6162-2, *Hydraulic fluid power — Flange connectors with split or one-piece flange clamps and metric or inch screws — Part 2: Flange connectors for use at pressures of 35 MPa (350 bar) to 40 MPa (400 bar), DN 13 to DN 51*

ISO 6164, *Hydraulic fluid power — Four-screw, one-piece square-flange connections for use at pressures of 25 MPa and 40 MPa (250 bar and 400 bar)*

ISO 10763, *Hydraulic fluid power — Plain-end, seamless and welded precision steel tubes — Dimensions and nominal working pressures*

ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

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

ISO 13851, *Safety of machinery — Two-hand control devices — Functional aspects and design principles*

ISO 16874, *Hydraulic fluid power — Identification of manifold assemblies and their components*

ISO 17165-1, *Hydraulic fluid power — Hose assemblies — Part 1: Dimensions and requirements*

ISO 23309, *Hydraulic fluid power systems — Assembled systems — Methods of cleaning lines by flushing*

IEC 60947-5-5, *Low-voltage switchgear and controlgear — Part 5-5: Control circuit devices and switching elements — Electrical emergency stop device with mechanical latching function*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5598 and ISO 12100 and the following apply.

3.1 function plate

surface that contains information describing either the performance of a manually operated device (e.g. ON/OFF, forward/reverse, left/right, up/down) or the status of a function performed by the system (e.g. clamp, lift, advance)

4 List of significant hazards

Table A.1 lists the significant hazards associated with the use of hydraulic fluid power in a machine.

5 General rules and safety requirements

5.1 General

5.1.1 When designing hydraulic systems for machinery, all intended operations and use of systems shall be considered. Risk assessment, e.g. in accordance with ISO 14121-1, shall be carried out to determine the foreseeable risks associated with systems when they are used as intended. Reasonably foreseeable misuse shall not cause hazards. The risks identified shall be eliminated by design and, where this is not practicable, safeguards (first preference) or warnings (second preference) against such risks shall be incorporated, in accordance with the hierarchy established in ISO 12100.

NOTE This International Standard provides requirements for components of fluid power systems; some of these requirements are dependent on the hazards associated with the machine in which the system is installed. Therefore, the final specification and construction of the hydraulic system could need to be based on risk assessment and agreement between purchaser and supplier.

5.1.2 The control systems shall be designed in accordance with the risk assessment. This requirement is met when ISO 13849-1 is used.

5.1.3 The prevention of damage to the machine, system and the environment shall be considered.

5.2 Basic requirements for the design and specification of hydraulic systems

5.2.1 Selection of components and piping

5.2.1.1 All components and piping in the system shall be selected or specified to provide for safety in use, and they shall operate within their rated limits when the system is put to its intended use. Components and piping shall be selected or specified so as to ensure that they can operate reliably under all intended uses of the system. Particular attention shall be paid to the reliability of components and piping that can cause a hazard in the event of their failure or malfunction.

5.2.1.2 Components and piping shall be selected, applied and installed in accordance with the supplier's instructions and recommendations, unless testing or field experience validates other components, applications or installations. Operator manuals for mobile machinery may exclude operation in certain situations.

5.2.1.3 It is recommended that, wherever practicable, components and piping made in conformance with recognized International Standards be used.

5.2.2 Unintended pressures

5.2.2.1 All related parts of the system shall be designed or otherwise protected against foreseeable pressures exceeding the maximum working pressure of a system or the rated pressure of any part of the system if the excessive pressure can cause a hazard.

Any system or part of a system that can be disconnected and sealed so that trapped fluid can be subject to a pressure increase or decrease (e.g. due to the change in a load or the fluid temperature) shall include means for limiting the pressure if the change can cause a hazard.

5.2.2.2 The preferred means of protection against excessive pressure is one or more pressure-relief valves located to limit the pressure in all related parts of the system. Other means, such as pressure-compensator pump controls, may be used to limit main system operating pressure, provided these means ensure safety under all operating conditions.

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5.2.2.3 Systems shall be designed, constructed and adjusted to limit pressure surges and fluctuations. Pressure surges and fluctuations shall not cause hazards.

5.2.2.4 Loss of pressure or pressure drop shall not expose persons to a hazard and should not damage the machinery.

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

5.2.3 Mechanical movements

In stationary industrial machinery, mechanical movements, whether intended or unintended (e.g. effects from acceleration, deceleration or lifting/holding of masses), shall not result in a situation hazardous to persons.

5.2.4 Noise

In the design of hydraulic systems, the expected noise shall be taken into account, and noise generation shall be minimized at its source. Depending on the application, measures shall be taken to minimize the risks caused by noise. Airborne, structure-borne and liquid-borne noise shall be considered.

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

5.2.5 Leakage

If leakage (internal or external) occurs, it shall not cause a hazard.

5.2.6 Temperature

5.2.6.1 Operating temperature

The full range of operating temperatures for the system or any component shall not exceed the specified limits at which they can safely be used.

5.2.6.2 Surface temperature

Hydraulic systems shall be designed to protect persons from surface temperatures that exceed touchable limits by either location or guarding; see ISO 13732-1. When such protection is not possible, proper warnings shall be provided.

5.2.7 Operational and functional requirements for hydraulic systems

The following specifications for operation and function shall be defined:

- a) working pressure range;
- b) working temperature range;
- c) type of fluid being used;
- d) working flow-rate range;
- e) lifting provisions;
- f) emergency, safety and energy isolation requirements;
- g) painting or protective coating.

Annex B (informative) provides forms and checklists to facilitate the gathering and recording of this information for stationary machinery. These forms and checklists may also be useful to record those specifications that apply to hydraulic systems used in mobile machinery.

5.3 Additional requirements

5.3.1 Site conditions and operating environment

Site conditions and operating environment that affect the requirements of hydraulic systems used in stationary industrial machinery shall be defined. Annex B (informative) provides forms and checklists to facilitate the gathering and recording of this information, which may include:

- a) ambient temperature range of the installation;
- b) humidity range of the installation;
- c) available utilities, e.g. electricity, water, waste;
- d) electrical network details, e.g. voltage and its tolerance; frequency, available power (if limited);
- e) protection for electrical circuits and devices;
- f) atmospheric pressure;
- g) sources of contamination;
- h) sources of vibration;
- i) possible severity of a fire, explosion or other hazard and availability of related emergency resources;
- j) required reserves, e.g. flow, pressure and volume;
- k) space for access, maintenance and use, as well as the location and mounting of components and hydraulic systems to ensure their stability and security in use;
- l) available cooling and heating media and capacities;
- m) requirements for the protection of persons and the hydraulic system and its components;
- n) legal and environmental limiting factors;
- o) other safety requirements.

Annex B may also be useful to record those environmental conditions that apply to the specification of a hydraulic system used in mobile machinery. The individual forms in Annex B are also available in a separate revisable electronic format.

5.3.2 Installation, use and maintenance of components, piping and assemblies

5.3.2.1 Replacement

To facilitate maintenance, means should be provided or components and piping fitted so that their removal from the system for maintenance

- a) minimizes the loss of fluid;
- b) for stationary machinery only, does not require the draining of the reservoir;
- c) does not necessitate an otherwise needless disassembly of adjacent parts.