INTERNATIONAL STANDARD 4413

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Hydraulic fluid power — General rules for the application of equipment to transmission and control systems

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up 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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 4413 was developed by Technical Committee ISO/TC 131, *Fluid power systems and components*, and was circulated to the member bodies in September 1976.

It has been approved by the member bodies of the following countries :

Australia	Hungary	Poland
Austria	India	Romania
Belgium	Italy	Spain
Brazil	Japan	Sweden
Bulgaria	Korea, Rep. of	Switzerland
Chile	Mexico	United Kingdom
Czechoslovakia	Netherlands	U.S.S.R.
Finland	Philippines	Yugoslavia

The member bodies of the following countries expressed disapproval of the document on technical grounds :

France
Germany

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0 INTRODUCTION

The guidance and recommendations given in this document have no legal status except for those paragraphs that may be included in contractual agreements between purchaser and supplier. Deviation from those parts of this document included in contractual agreements shall also be agreed to in writing by the purchaser and supplier.

Recommendations which contain the verb "shall" are counsels of good engineering practice, universally applicable with rare exception. Use of the word "should" in the document is not an indication of choice but an indication that the desirable engineering practices described may have to be modified due to the peculiarities of certain processes, environmental conditions or equipment size.

Titles or parts of the text which are marked with an asterisk (*) indicate sub-clauses that need discussion between the purchaser and supplier to define the requirements and/or responsibility.

Attention shall be drawn by the purchaser and/or supplier to applicable national or local codes or laws.

Use of this document will assist

a) in establishing safety requirements and safe practices (the titles of sub-clauses relating to safety are underlined; the use of the word "hazard" implies possible risk of danger to personnel);

b) a purchaser in writing a specification for hydraulic equipment;

c) a purchaser in establishing the relative merits of similar hydraulic equipment;

d) a manufacturer in producing acceptable hydraulic equipment to his own design or to the customer's specification.

Clause 4 onwards shall not be used in isolation without due reference to clauses 1 and 2.

The term "manufacturer" implies the contractual supplier for warranty and service purposes.

1 SCOPE AND FIELD OF APPLICATION

This International Standard provides recommendations relating to hydraulic systems on machinery used in industrial manufacturing processes. It is intended as a guide for both manufacturers and purchasers, with a view to ensuring

a) safety of personnel;

b) ease and economy of maintenance;

c) uninterrupted production;

d) long life of equipment.

2 REFERENCE

ISO 1219, *Fluid power systems and components — Graphic symbols.*

3 DEFINITIONS

For the definition of terms used in this document, an International Standard is in preparation.

4 GENERAL REQUIREMENTS

The requirements stated in this clause apply to all equipment within the scope of this document.

4.1 Safety

4.1.1 *Fail-safe concept*

When designing hydraulic circuits, all aspects of possible methods of failure (including control supply failure) shall be considered. In each case, components shall be selected, applied, fitted and adjusted so that in the event of a failure, maximum safety of personnel shall be the prime consideration, and damage to equipment minimized.

4.1.2 *Application concept*

a) All components within the system shall operate within their manufacturer's specification.

b) All parts of the system shall be protected against over-pressure.

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

d) Circuits shall be designed, constructed and adjusted to minimize surge pressures.

e) Surge pressure or loss of pressure shall not cause hazards.

4.1.3 *Safety requirements*

All safety requirements (which are underlined throughout this International Standard) are reproduced in the annex.

4.2 Specification requirements

4.2.1 *Special site conditions**

The supplier and purchaser shall discuss any special site conditions, and the design of the system shall take account of these conditions. Examples of information required are :

a) vibration; excessive contamination; high humidity;

b) the siting of equipment at altitudes above 1 000 m above sea level;

c) the possible existence of a fire hazard;

d) the standard of maintenance available;

e) electric network details, *i.e.* voltage and its tolerance, frequency, available power (if limited), etc.;

f) protection for electrical devices.

4.2.2 *System temperature*

4.2.2.1 HEAT GENERATION

Hydraulic circuits shall be designed to minimize unnecessary heat generation.

4.2.2.2 OPERATING TEMPERATURES*

The full range of ambient temperatures in which the equipment will be located shall be stated. The pump inlet temperatures should not exceed 60 °C for mineral oil when maximum ambient temperatures exist. The equipment shall operate satisfactorily under conditions of minimum ambient temperatures.

Special conditions may apply for other fluids.

4.2.3 *Maintenance requirements*

4.2.3.1 EQUIPMENT LOCATION

Hydraulic equipment and piping shall be accessible and fitted so as not to interfere with the adjustment or maintenance of the equipment. Particular attention shall be given to the location of equipment which needs regular maintenance.

4.2.3.2 COMPONENT REMOVAL*

To facilitate maintenance, means shall be provided or components so fitted that their removal from the system for maintenance shall not

a) lead to excessive loss of fluid;

b) require draining of the reservoir;

c) necessitate extensive disassembly of adjacent parts.

4.2.3.3 LIFTING PROVISIONS

All components, equipment or assemblies having a mass greater than 15 kg shall have accessibility and provision for lifting.

4.2.3.4 EQUIPMENT INSTALLATION

All components shall be installed and used in accordance with manufacturers' recommendations.

4.2.4 *Layout drawings*

4.2.4.1 FLOOR AND FOUNDATIONS

The supplier shall provide the purchaser with details of the floor plan and foundation requirements. If there are two or more assemblies, the dimensional relationships shall be specified.

4.2.4.2 PIPING*

Where requested on the purchaser's enquiry and confirmed on the supplier's quotation, a piping layout shall be furnished by the supplier. Photographs which clearly show the piping arrangement and assembly may be substituted for the layout by agreement.

4.2.5 *Procurement of equipment*

The supplier should use commercially available parts (keys, bearings, packings, seals, washers, plugs, fasteners, etc.) and part configurations (shaft and spline sizes, port sizes, mountings, interface patterns, etc.) which are manufactured to established International Standards, and which provide for uniform coding.

4.2.6 *Language**

The purchaser and supplier shall agree on the language to be used in technical data, and the supplier shall be responsible for ensuring that the translation has the same meaning as the original text.

NOTE – An International Standard on graphic representation of pipe-lines is in preparation.

4.2.7 *Maintenance data*

The supplier shall provide the purchaser with maintenance data for all hydraulic equipment which clearly

a) describe start-up and shut-down procedures;

b) describe adjustment procedures;

c) indicate external lubrication points and the type of lubricant required;

d) state maintenance procedures for unique assemblies;

e) locate fluid level indicators, fill points, drains, filters, test points, strainers, magnets, etc., that require regularly scheduled maintenance;

f) give instructions for fluid maintenance;

g) give further identification of parts in the hydraulic components which are commercially available or manufactured to an International Standard that provides for uniform coding; the identification shall be the part manufacturer's part number or as provided by the standard's code;

h) list recommended spare parts.

4.2.8 *Testing*

4.2.8.1 PERFORMANCE TESTS

Hydraulic systems shall be completely performance tested to determine compliance with this document and the contract specifications.

4.2.8.2 NOISE LIMIT*

Installed hydraulic equipment shall be in accordance with noise levels agreed at the time of contract.

4.2.8.3 FLUID LEAKAGE

There shall be no unintentional external leakage from the hydraulic system at the time of purchaser's acceptance.

4.2.9 *Data to be provided by the supplier*

The following data shall be provided.

4.2.9.1 FINAL DATA

a) Final diagrams, drawings, and texts, including the maintenance data, shall conform to the equipment shipped and be forwarded to the purchaser not later than the time of equipment delivery.

*b) Where requested on the purchase order or the enquiry, final diagrams and drawings shall be on reproducible material which shall not be folded.

4.2.9.2 MAINTENANCE MANUALS*

The supplier shall advise the purchaser regarding the availability of maintenance manuals for standard equipment [as described in 4.2.7 g) and h)].

4.2.9.3 MODIFICATIONS

Whenever modifications are made by the supplier, they shall be recorded and the purchaser shall be notified.

4.2.10 *Preparation for transportation*

4.2.10.1 IDENTIFICATION OF PIPING

Where construction of the equipment requires transporting in sections, removed piping runs and their corresponding terminal ports and/or connectors shall be identically marked.

4.2.10.2 PACKAGING*

All equipment shall be packaged in a manner that protects it from damage and distortion, and preserves its identification during transportation.

4.2.10.3 SEALING OF OPENINGS

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

4.3 Presentation of technical data

In the preparation of circuit diagrams and technical data the procedures specified in 4.3.1 and 4.3.2 shall be adopted.

4.3.1 *Circuit diagrams*

a) Circuit diagrams shall use symbols from ISO 1219. An International Standard is in preparation for graphic representation of pipelines.

b) The symbols shall, unless otherwise indicated, represent units at rest (i.e. all power off, circuits depressurized and ready-for-start).

c) Symbols shall be positioned on the diagram so that the circuit is easy to follow. It is not necessary for the symbol position to correspond to the physical location of the device depicted.

d) Cross-over of lines should be kept to a minimum.

e) Each item on the circuit diagram shall have a separate designation or identification (see 4.4.2 and 4.4.4.1).

f) Ports, test points, bleed points and orifice fittings should be identified (see 4.4.3 and 7.2.6).

g) Flow lines between power units and machines shall be identified at both ends.

4.3.2 *Technical data*

The following information shall be included on or with the circuit diagram :

a) identification of all hydraulic equipment by name, catalogue number, serial or design number, and the manufacturer's name;

b) the size, wall thickness and specification of pipe, tube and hose lines;

c) the diameter of each cylinder piston and rod, the length of stroke, the estimated force and the speed required for the intended service;

d) the displacement per revolution, the torque output speeds and direction of rotation required for the intended service of each hydraulic motor;

e) the rate or rates of flow, and the direction of rotation of each pump looking at the driven shaft end;

f) the power, rotational frequency, and the type of each pump drive motor;

g) the pressure setting of each pressure control valve;

h) the types of strainers and filters, and preferably details and quantity of replacement elements;

i) the volume of fluid required to fill the system to maximum level;

j) the recommended fluid type and viscosity range;

k) when specified, the time sequence chart, for example the time range of the cycle, and data or text, or both, showing the operations performed including the function(s) of the related electrical and mechanical controls and actuating equipment;

l) clear indication of any circuitry contained within circuit manifolds; where boundary lines or boundary envelopes are used for this purpose, the boundary indicated shall not include any symbol of a component not mounted on or within the circuit manifold;

m) clear indication of the function of each actuator in each direction;

n) the pre-charge pressure and nominal volumes of accumulators;

o) the size, type and location of test and bleed points in the circuit;

p) identification of all component or manifold ports (as marked on the component);

q) the expected flow-rate and maximum and minimum pressure of the cooling media, and the maximum temperature of the cooling media supply.

4.4 Identification

4.4.1 *Components*

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

a) the manufacturer's name and brief address;

b) the manufacturer's type or model number;

c) symbols according to ISO 1219, and all ports correctly identified;

d) the safe maximum continuously-rated pressure.

Where lack of available space would result in lettering too small to be legible, information may be restricted to a minimum of manufacturer's name and type or model number.

In addition, the specific particulars indicated in table 1 shall be shown.

4.4.2 *Components within a system*

Each hydraulic component shall be allocated an item number and/or letter. This item number shall be used to identify the component on all diagrams, lists and layouts. It should be plainly and permanently marked on the installation adjacent to, but not on, the component.

4.4.3 *Ports*

Component ports, including pilot ports, test and bleed points, etc., shall be plainly and permanently identified and the same identification used on the circuit diagram.

4.4.4 *Valve actuating devices*

4.4.4.1 ACTUATORS, OTHER THAN ELECTRICAL

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

4.4.4.2 ELECTRICAL ACTUATORS

Electrical actuators shall be identified on the electrical and hydraulic circuit diagrams with the same actuator identification.

4.4.5 *Internal devices*

Cartridge type values and other functional devices (orifice plugs and 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 be provided adjacent to the component and marked "Concealed".

4.4.6 *Control station nameplates*

A nameplate shall be provided for each control station component and located where it can be easily read by the equipment operator. The nameplate information shall be relevant and easily understood, providing positive identification of the actuator function controlled.

5 ENERGY CONVERSION

5.1 Pumps and hydraulic motors

5.1.1 *General*

5.1.1.1 PROTECTION

Pumps and hydraulic motors shall either be mounted where they are protected from predictable damage, or be suitably guarded.

5.1.1.2 DRAINS

The size and termination of pump and motor drains shall meet the component manufacturer's specification.

5.1.1.3 PRE-FILLING OF HOUSINGS

Where the manufacturer's specifications require pre-filling the housings of pumps or motors with fluid prior to start-up, a readily accessible means for pre-filling shall be provided, and be so located as to ensure that air is not entrapped in the housing.

TABLE 1 — **Additional information to be given on components**

Components	Information and legend	Remarks
1) Pumps	Displacement/rev Direction of rotation	
2) Hydraulic motors	Displacement/rev Direction of rotation relative to porting	
3) Cylinders	Cylinder bore diameter Piston rod diameter Length of stroke Length of stop tube	 If fitted
4) Pressure control valves	Range of pressure adjustment	
5) Solenoid-operated valves (marked on the solenoid or coil)	Voltage A.C. frequency or D.C. Protection classification	 In accordance with relevant IEC publication
6) Pressure switches	Range of pressure adjustment Pressure differential range Voltage and current-carrying capacity of switch Protection classification	 In accordance with relevant IEC publication
7) Hydraulic accumulators (on the shell)	Serial number Year of manufacture (shell and also bag assembly, as applicable) Total shell volume (litres) Maximum allowable pressure Proof pressure legal stamp Test date	 If legally required If legally required
(on a label adjacent to accumulator)	Gas pre-charge pressure "Use only nitrogen"	*NOTE — Other gases may be used if agreed by the manufacturer of the accumulator and the purchaser.
8) Filters	Direction of flow Type number and rating of elements	 In accordance with relevant International Standard
9) Heat exchangers	Directions of flow of both working and cooling media Nature and maximum pressure of the transfer fluid	

5.1.1.4 DRIVE COUPLING

5.1.1.4.1 Type and alignment

Couplings shall be of a type approved by the pump or motor manufacturer for the specified type of mounting and alignment tolerances.

5.1.1.4.2 Fitting procedure

Pump or motor manufacturer's recommended procedure shall be used when fitting the coupling to the shaft.

5.1.1.5 COUPLING GUARDS

Rotating shafts and couplings shall be guarded to provide adequate protection against hazard.

5.1.2 *Pumps*

5.1.2.1 MOUNTINGS

The pump and its drive motor mountings shall be sufficiently rigid to ensure adequate alignment at all times.

5.1.2.2 INLET CONNECTIONS

a) Pump inlet piping shall be designed so that pump inlet pressure and other conditions are in accordance with the pump manufacturer's recommendations.

b) Inlet pipes should be as short and straight as possible, and be free from sudden changes in cross-section.

c) Inlet pipes, strainers and filters shall be free from air leaks and should contain no pockets which could collect air bubbles.

5.1.2.3 DISCHARGE CONNECTIONS

Means shall be provided in the pump discharge line for purging air from the pump during initial start-up.

5.1.2.4 SUBSIDIARY CONNECTIONS

Drains, air bleeds, etc., shall be so installed that they do not allow ingress of air into the system.

5.1.3 *Hydraulic motors*

5.1.3.1 MOUNTINGS

The mounting of motors on, or in relation to, their drive assemblies shall be sufficiently rigid to ensure adequate alignment at all times.

5.1.3.2 OUTPUT CHARACTERISTICS

The starting and stall torques, the effect of load variations, and the kinetic energy of the moving load, shall be considered in the application of rotary motors.

5.2 Cylinders

5.2.1 *Resistance to buckling*

Special attention shall be given to stroke length, loading and the conditions of assembly in order to avoid abnormal bending or buckling of the cylinder piston rod in the extended condition. This is particularly important if the cylinder has non-rigid mountings.

5.2.2 *Alignment*

The alignment of rigidly mounted cylinders with dependent slides and other guided equipment elements shall apply no undue side load to the piston rod.

5.2.3 *Mounting*

5.2.3.1 FIXING SCREWS

Fixing screws for foot-mounted cylinders shall be of a size that will take all the predictable shear forces without any safety risk, unless the mounting is keyed or dowelled.

5.2.3.2 MOUNTING SURFACES

Mounting surfaces shall not distort cylinders, and allowances shall be made for thermal expansion.

5.2.4 *Maintenance*

Piston rod seals or seal assemblies should be easily replaceable.

5.2.5 *Component replacement*

Integral cylinders are undesirable but where they are used, components liable to wear should be replaceable.

5.2.6 *Cushions*

Cylinder end stops shall be protected from damage due to high external loads.

5.2.7 *Piston rods*

5.2.7.1 PISTON AND ROD ASSEMBLY

Pistons shall be positively locked to the piston rod.

5.2.7.2 MATERIALS*

If required, hard-surface or corrosion-resistant rods shall be specified.

5.2.7.3 PROTECTION

Piston rods shall be protected from predictable damage.

5.2.7.4 PISTON ROD ENDS

For assembly purposes, piston rods with male or female screwed ends shall be provided with flats to suit standard spanners.

5.2.8 *Air entrapment*

5.2.8.1 PORT LOCATION

Where practical, cylinders shall be installed with ports uppermost.

5.2.8.2 AIR BLEEDS

Cylinders shall be mounted so that they are self-bleeding, or accessible external air bleeds shall be provided.

5.2.9 *Piston stroke*

The stroke of the piston shall always be greater than or equal to its nominal stroke.

6 VALVES

6.1 Mounting

6.1.1 *Method*

Surface-mounted and/or cartridge valves should be used wherever practicable, so that they can be readily replaced without disturbing pipework.

6.1.2 *Orientation*

Surface-mounted and cartridge valves shall have means of ensuring correct orientation.

6.1.3 *Attitude*

To ensure fail-safe conditions, the effect of gravity, impact or vibration on the main elements of a valve shall be considered when mounting any valve.

6.2 Fail-safe valves

Any actuator required to maintain its position during start-up, stopping or in the event of a control system failure, shall be controlled by a valve which is either spring biased to its fail-safe position or detent located.

6.3 Valve actuators

6.3.1 *Mechanically actuated valves*

Mechanically actuated valves shall be designed or installed in such a way that an overload or overtravel will not cause damage.

6.3.2 *Electrically actuated valves*

6.3.2.1 ELECTRICAL CONNECTIONS

Cable entry or connector to valve actuators and the spacing of adjacent valves shall allow for the use of protective conduit.

6.3.2.2 TERMINAL BLOCK HOUSING

Terminal block housings should have

a) adequate space for the terminal block and for sufficient free cable to allow for easy servicing;

b) captive fasteners for the cover;

c) suitable means to prevent loss of cover.

6.3.2.3 SOLENOIDS

Solenoids shall

a) be capable of operating without malfunction at the nominal voltage within 10 %;

b) be protected against the entry of splashed fluid and dirt.

6.3.2.4 MANUAL ACTUATION

Electrically actuated valves shall incorporate facilities to be operated manually unless otherwise specified. It shall not be possible to operate these facilities unintentionally.

6.4 Identification of actuation

Symbol plates shall be attached to the valve in such a way that the positions and controls represented agree directionally with the actuator movement.

7 ENERGY TRANSMISSION AND CONDITIONING

7.1 Fluids

7.1.1 *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.

7.1.2 *Compatibility*

7.1.2.1 ALL FLUIDS

The hydraulic fluid used shall be compatible with all the components and elastomers used in the system and be in accordance with the recommendations of the equipment manufacturers.

7.1.2.2 FIRE-RESISTANT FLUIDS

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

a) protective finishes and other fluids associated with the system; for example paints, process and/or service fluids;

b) 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.

7.1.3 *Handling precautions*

Advisory information shall be provided by the system or fluid supplier on hygiene requirements for personnel when handling the fluid, on any toxic or asphyxiating hazard in the event of a fire and on any problems in the disposal of waste fluid.

7.1.4 *Maintenance*

Means shall be available for carrying out fluid maintenance procedures recommended by the fluid or system manufacturer.

7.1.5 *Filling and maintenance of fluid level**

Fluids used for filling and maintaining the fluid level should be filtered during this process through a built-in or purchaser's own portable filter with a similar or finer rating to that used in the system.

7.2 Piping, fittings and fluid passages

7.2.1 *Fluid velocity and compressibility*

The fluid velocity through piping, fittings and manifolds shall be such that the resulting pressure drops at all working temperatures and the system capacitance do not adversely