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STANDARDS FOR FLUID POWER SYSTEMS

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S U M M A R Y

This paper deals with the application of industrial standardization to fluid power systems and components. Different levels and modes of standardization are considered, with particular reference to the fluid power field. The general absence of extensive standardization of fluid power equipment is noted, and reference is made to the difficulties this creates for users. Reference is made to the scope of existing national standards in this area. An account is given of the comprehensive approach to standardization of fluid power systems and components now being undertaken at the international level (through ISO/TC131) and the possibility of Australian participation in this work is considered.

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The purpose of this paper is to examine both past experience and future possibilities in relation to the development of industrial standardization in the field of fluid power.

By way of introduction it will be useful to consider some quite general aspects of standardization in relation to any specific industrial subject. In particular, let us consider (i) the levels at which standardization may be undertaken, and (ii) the various possible modes or aspects of standardization.

Dealing first with possible levels of standardization we may take note of -

(1) the individual firm

(2) the trade or industry association within a particular country

(3) the national standards body in a particular country

(4) the regional body covering a group of closely related countries

(5) the international standards body.

In amplification of this classification, it is clear first that any firm specialising in a particular field must normally establish some standards of its own as to the range of equipment to be supplied. While there are some firms who take the line that they will supply anything demanded by a client, the economics of mass production usually mean that, so far as they can, they will adhere to some standards in relation to basic materials and components, if not for complete systems. To the extent that these standards are peculiar to individual producers, they present disadvantages to users, who find that once committed to a particular system, they are limited in subsequent choices and hence in securing competitive tenders for supply of equipment, and also in relation to maintenance of the system.

At some stage, however, even competing suppliers, if only because of pressure from users or other sources, find that they must get together on common standards, at least in certain basic respects. This leads to the development of standards at the manufacturers' association level, and even more at the level of the industrial association which incorporates both producers and users.

It is only a further step then towards the promulgation of standards at a national level, where producers of the equipment, suppliers and users at all levels, and other interests, including educational bodies and perhaps also statutory authorities, develop a consensus as to desirable practice in relation to some aspects of the total subject.

Where, as in Europe, there is a closely knit community of countries, with exchange of products, of technology using those products, and of labour, pressure arises for the development of standards at a regional level. And as technology extends beyond regional boundaries, this leads to a demand for fully international standards.

Turning now to the modes or aspects of standardization to be applied to a particular product, we may envisage a more or less rational development applied in turn to -

(1) units

(2) terminology

(3) graphical symbols and drawing practice

(4) test methods

(5) safety factors

(6) ratings

(7) dimensional standards for materials and components

(8) performance of components and of systems

(9) codes of practice for operation and maintenance

and so on. This analysis is more or less self-explanatory and needs little elaboration.

Although hydraulic and pneumatic transmission and control systems have found extensive application over a very wide range of industries for a great many years, the fluid power industry is one which has come only in recent years to the standardization process. A survey of trade association standards, national standards, regional standards and international standards indicates that most of these standards date back only a relatively few years; 1968-69-70 have been the years of greatest standards development in the fluid power area.

The levels of standardization classified above are reflected in the development of fluid power standards throughout the world. The technical literature promulgated by the leading suppliers of fluid power equipment in various countries (U.S.A., U.K., Japan, European countries, etc.) are in effect indicative of the private standards that have been developed, though when it comes to customer requirements for systems, there has of course been a fair degree of "custom design" as distinct from standardization. At the industrial association level, the activity of the National Fluid Power Association in the U.S.A. is the best example but the V.D.I. in Germany have also done a good deal of work. At the regional level, much work has been done by the CETOP group in Europe. At the fully national level, many countries, particularly in Europe, have recently produced a variety of standards; Japan is also deserving of mention in this respect, but not much has been done in U.K. Internationally the only standard so far produced is ISO/R1219, which deals with graphical symbols for hydraulic and pneumatic equipment, but as indicated below, a much broader approach to international standardization is being planned.

A survey of internationally-recorded standards for fluid power indicates that there are something approaching 300 national or near-national standards now promulgated, but these don't really embrace any in-depth standardization in the area concerned. Some are concerned with fairly primitive modes of standardization, such as units, graphical symbols and terminology. Many are related to definition and classification of basic parameters and principal operating characteristics of systems and components - to forms of rating, to nominal values of pressure, flow, etc., to efficiencies, and so on. Test methods seem to have received relatively little attention; there is a British standard for testing of control valves, and a U.S. NFPA standard covering performance testing of pumps and motors. Piping and pipe fittings, including threaded connections and hose couplings, have received some attention, particularly in Sweden. Other dimensional aspects have not been widely covered - some countries have dealt with mounting dimensions, and with such things as cylinder bores, port sizes, O-rings and the like, to a limited extent only. Particular materials such as hydraulic oils and hoses are the subject of a few national standards. Little has been done on the subject of safety factors and requirements, and only sporadic attention has been given to the development of codes of practice for inspection, operation and maintenance, or for hydraulic transmission and control systems as a whole.

Here in Australia there has been only very sparse standards activity - in fact the national standards body, the Standards Association of Australia, has not yet formed any committee for fluid power standards. As a result of liaison with SAEA, three standards have been promulgated - one for terminology (based very closely on the U.S. NFPA standard), one for hydraulic fluids, and one for graphical symbols (based on the British standard); the last-mentioned is currently under revision. Some steps were taken, again on an SAEA initiative, towards preparation of an Australian standard for hydraulic transmission and control systems for industrial equipment, but this has been delayed because the U.S. JIC standard is under revision. There has been some pressure on SAA to do something about hydraulic systems for agricultural machinery but this work has not yet got off the ground. A standard has been issued for motor vehicle brake fluids, and some work has been done on O-rings.

It is perhaps significant that much of the pressure for standards in relation to fluid power has come from specialised user groups. This is indicated particularly in U.S.A. experience. Several years ago the "Joint Industry Conference", comprising users of major items of industrial equipment (machine tools, etc.), especially in the automotive field, undertook the development of standards for hydraulic transmission and control systems; a standard was issued and is now under revision. The manufacturers of agricultural machinery, incorporating hydraulic systems, found themselves caught between the varieties provided by hydraulic equipment suppliers and the maintenance problems of the ultimate machinery users, so that the American Society of Agricultural Engineers found itself obliged to develop standards for hydraulic systems and components. In a similar way the aeronautical industry found itself confronted with special needs and the U.S. Society of Automotive Engineers developed an SAE-ARP series of standards covering some aspects of hydraulic systems.

As indicated in the earlier brief survey of current standards coverage, the range of existing national standards is very diverse and far from providing a comprehensive system of standardization in this field. It is therefore appropriate and timely that the most significant development in standardization for fluid power systems and components is the formation of an international technical committee, ISO/TC131. Some earlier work had been undertaken through ISO/TC39 - Machine Tools, but this has been taken over under the aegis of ISO/TC131. This was formed as a result of an American initiative, and the American National Standards Institute (ANSI) holds the Secretariat. The actual work is however being handled by the U.S. National Fluid Power Association.

The scope of this committee is defined in the following terms:
Scope Standardization in the field of fluid power systems and components, comprising terminology, construction, principal dimensions, safety requirements and testing and inspection methods.

To include such components as:

accumulators
compressed air dryers
conductors (rigid and flexible)
cylinders
electro-hydraulic servovalves
fittings
fluidic devices
hose fittings and assemblies
filters and separators
fluids
hydraulic pumps
motors
moving-part-fluid-controls
pneumatic lubricators
regulators
quick disconnect couplings
reservoirs
sealing devices
valves
etc.

Note: "Fluid power" is defined as energy transmitted or controlled through an enclosed pressurised fluid. Typical fluids are petroleum oils, water, water-oil mixtures, synthetic fluids, air and other gases.

The first meeting was held in London from 8-11 September 1970, when a comprehensive range of sub-committees was established, as follows:

SC 1 - Terminology, Classification and Symbols	Secretariat : Japan
SC 2 - Pumps, Motors and Integral Transmissions	Secretariat : Germany
SC 3 - Cylinders	Secretariat : Sweden
SC 4 - Ports, Fittings, Tubes, Hoses, Hose Fittings and Assemblies	Secretariat : Sweden
SC 5 - Control Components	Secretariat : France
SC 6 - Fluids and Filtration	Secretariat : Italy
SC 7 - Sealing Devices	Secretariat : U.S.A.
SC 8 - Component Testing	Secretariat : U.K.
SC 9 - Installations and Systems	Secretariat : U.K.

It will be clear from this listing that the effort is a truly international one.

Australia is listed as a participating (P) member both of ISO/TC131 and of all the sub-committees. Steps are being taken to call a general conference to encourage Australian participation in this work, and to form several small Australian groups to keep a watch on the activity of each of the ISO/TC131 sub-committees, through receiving the documents and, where appropriate, presenting Australian comments on them.

One advanced activity of ISO/TC131 relates to the designation of a range of standard nominal pressures. These are expressed in bars (1 bar = 10^5 newtons per square metre = 0.1 megapascal). For the range 0.01 to 160 bars, the preferred standard pressures are the R5 series of preferred numbers, with secondary non-preferred pressures based on the R10 series. For the range 200-1000 bars, the standard pressures follow the R10 series. The complete range is as follows (where non-preferred values are given in brackets) :

0.01	1.0	100
(0.0125)	(1.25)	(125)
0.016	1.6	160
(0.02)	(2.0)	200
0.025	2.5	250
(0.0315)	(3.15)	315
0.04	4.0	400
(0.05)	(5.0)	500
0.063	6.3	630
(0.08)	(8.0)	800
0.10	10	1000
(0.125)	(12.5)	
0.16	16	
(0.2)	(20)	
0.25	25	
(0.315)	(31.5)	
0.4	40	
(0.5)	(50)	
0.63	63	
(0.8)	(80)	

Several of the sub-committees are becoming active and already many initial proposals have been circulated, as indicated in the appended list.

Summing up, it is to be hoped that as international draft standards of some substance are developed, it may become reasonable to consider the promulgation of corresponding Australian standards, so that Australian industry - producers of fluid power systems and components, those who incorporate these in industrial equipment, and those who use the industrial equipment - will be provided with a range of standards that will serve to ensure uniformity in practice, to promote a truly competitive situation, and to ensure a greater degree of interchangeability, in the interests of the fluid power industry as a whole.

A P P E N D I X

LIST OF DOCUMENTS ILLUSTRATING CURRENT ISO/TC131 WORK

The following list of documents is provided to indicate the lines along which the work of the presently active sub-committees of ISO/TC131 is developing.

Sub-committee 3 - Cylinders

N 1 - Threaded port sizes for inch series square head industrial pneumatic cylinders (an NFPA document).

N 2 - ISO/DR 1939 - Pneumatic cylinders - cylinder bores and port sizes.

N 3 - ISO/DR 2091 - Hydraulic cylinders - internal diameters - metric series.

N 4 - Bore and rod size combinations and rod end configurations for square head industrial fluid power cylinders.

N 5 - Specifications for hydraulic cylinder tubes.

N 6 - Hydraulic cylinder steel tubes (Swedish proposal).

N 7 - Oil hydraulic power cylinders.

N 8 - Merged inch and metric series mounting dimensions and rod and bore sizes for square head industrial fluid power cylinders (an NFPA document).

N 12 - Basic series of cylinder bore and piston rod sizes.

N 14 - Mounting dimensions of single rod double acting pneumatic cylinders - 10 bar (U.K. proposal).

N 15-27 Hydraulic and pneumatic jacks (French proposal).

N 29 - Hydraulic and pneumatic cylinders (Japanese proposal).

N 30 - Basic (inch) series of cylinder bore and piston rod sizes.

N 32 - Pneumatic cylinders - cylinder bores and port sizes - inch series.

N 33 - Basic series of cylinder bore and piston rod sizes (Polish proposal).

Sub-committee 4 - Ports, Connectors, Tubes, Hoses, Hose Fittings and Assemblies

N 1 - DR 1941 Flat seal for hydraulic couplings.

N 2 - DR 1943 Coupling threads for hydraulic or pneumatic piping.

N 3 - DR 1944 Pipe couplings for hydraulic piping.

N 4 - Straight threaded port with O-ring seal intended for the adapter contained in ISO/R 1941 - Flat seal for hydraulic couplings (Swedish proposal).

N 5 - Inch series straight thread connection with O-ring seal.

N 6 - Metric series straight thread connection with O-ring seal.

N 7 - O-ring connections. Stud ends, port threads, recesses and O-ring.

N 8 - Connection of flexible hydraulic tubing.

N 9 - Hydraulic fluid power hose fittings.

N 10 - Electric resistance welded mandrel drawn hydraulic line tubing (ANSI standard).

N 11 - Seamless low carbon steel hydraulic line tubing (ANSI standard).

N 17 - Hydraulic fluid power hose assembly test requirements.

Sub-committee 6 - Fluids and Filtration

N 2 - Practice for the use of fire resistant fluids for hydraulic fluid power systems.

N 3 - Method for extracting fluid samples from the lines of an operating hydraulic fluid power system (for particulate contamination analysis).

N 4 - Method for verifying the flow fatigue characteristics of a hydraulic fluid power element.

N 5 - Method for verifying the collapse/burst resistance of a hydraulic fluid power element.

N 6 - End load test method for a hydraulic fluid power filter element.

N 7 - Method for determining the fabrication integrity of a hydraulic fluid power filter element.

N 8 - Method for verifying the material compatibility of a hydraulic fluid power filter element.

N 9 - Standard procedure for qualifying and controlling cleaning methods for hydraulic fluid power fluid sample containers.

N 12 - Method for calibration of liquid automatic particle counters using "AC" fine test dust.

N 13 - Requirements for hydraulic fluid power filter and separator housings.

N 14 - Filters for oil hydraulic use (Japanese standard).

N 15 - Filters for pneumatic use (Japanese standard).

Sub-committee 7 - Sealing Devices

N 1 - O-rings. Inch series.

N 2 - O-rings. Metric series.

N 6 - Methods for measuring dimensions of multiple lip packing sets.

N 7 - O-rings (French proposal).

N 8 - O-rings (Japanese proposal).

N 9 - Metric dimensions of O-rings and their housings.