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Business Process Document

Guidance for design, specification and maintenance of hydraulic fluid power systems

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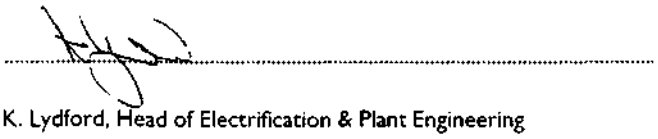

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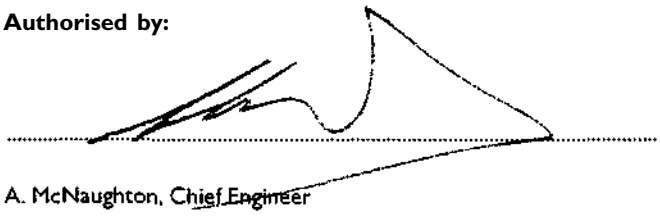

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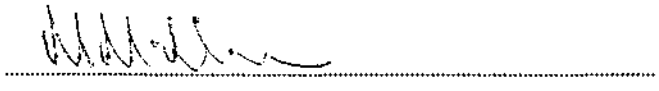

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1 Purpose

This guidance note has been prepared to control the design and maintenance of hydraulic fluid power systems.

2 Scope

This guidance note provides recommendations relating to hydraulic systems on plant and machinery. It is intended to augment B.S.4575: Part 1 and covers in

PART A Particular details to be considered when DESIGNING a hydraulic system.

PART B General maintenance requirements to help maintain uninterrupted performance and maximise equipment life.

3 Reference documentation

B.S. 4575	Fluid power transmission and control systems.
	Part 1 Guide for hydraulic equipment and systems.
	Part 3 Code of Practice for the technical specification, design, construction, commissioning and safe application of hydraulic and pneumatic fluid power systems.
B.S. 4641	Electroplated coatings of chromium for engineering purposes.
B.S. 5244	Application, storage and life expiry of hydraulic rubber hoses and hose assemblies.
B.S. 6275	Hydraulic fluid power filter elements.
	Part 1 Method of evaluating filtration performance (Multi-Pass method). Identical to ISO 4572.
A.H.E.M. P5	Guidelines to contamination control in hydraulic fluid power systems.
	Association of Hydraulic Equipment Manufacturers.
A.H.E.M. P9	Guidelines for the flushing of hydraulic systems.
	Association of Hydraulic Equipment Manufacturers.

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Part A Design of hydraulic systems

1 General

This part of the document is intended to assist a B.R. designer in the design of hydraulic systems and to assist Engineers in the review of proposed systems. The basis of a design should be as laid down in section B of this document but with the following details also being considered.

To help in reviewing a design the Engineer should use the design check list detailed in Appendix A.

2 Temperature control

2.1 Working temperature

A reasonable temperature limit for mineral oils is 60 deg C, for water-in-oil emulsions and water-glycols it is 50 deg C. Higher temperatures are acceptable for silicone and some other synthetic hydraulic fluids. Heat is generated within a circuit due to losses.

One method of minimising this heat generation effect is to have sufficient reservoir capacity to suit the particular system. The generally accepted and recommended minimum is 3 times the maximum pump displacement. (E.G. if the system has a maximum pump displacement of 150 litres/min. then the reservoir capacity should be a minimum of 450 litres).

2.2 Other heat energy inputs

Apart from high pressure leakage other heat energy inputs are introduced due to losses across restrictors and valves. Careful attention to design should minimise such inputs. An example of poor design is use of a high pressure relief valve to divert flow where a more efficient means of pressure control could be utilised. In some systems sources of external energy inputs should also be taken into account for example through hydrostatic braking.

2.3 Cooling

All factors affecting temperature should be considered and careful attention should be given to circuit cooling at the design stage. The aim should be to maintain each circuit within its operating temperature range and fluid should be cooled centrally as required by an adequately sized heat exchanger on its return to the reservoir. Consideration should be given to the location of the heat exchanger, with excessively warm areas such as engine housings being avoided.

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3 Contamination control

3.1 Filter selection

Filter ratings should take in to account the relative sensitivity of the components to contamination, operating pressure, the severity of the duty cycle and any special considerations such as the need for extreme reliability.

For an explanation of the "Multipass" method see Appendix B.

3.2 Component protection

Where filters are used for component protection the element should be of adequate size and rating. In such cases the filters shall be positioned upstream and as close to the component as possible to give maximum protection. Relatively coarse pressure filters may be used to protect against catastrophic failure providing that a filter to control the general level of contaminant is sited elsewhere in the system.

3.3 Maintaining general cleanliness

To achieve the cleanliness level specified, filters should be sited in a main flow line.

Alternatively supplementary off-line or return line filters subject to constant flows may be used. Return line filters shall be of adequate size to avoid excessive back pressure build-up due to increased flow when accumulators or cylinders with large differential areas are incorporated.

3.4 System considerations

Once the rating and capacity of the element has been chosen, the designer must ensure that the filter assembly is suitable for the duty for which it is intended. Factors that must be considered are material compatibility with the fluid at the maximum working temperature, collapse and burst resistance and fatigue rating of the element and housing.

3.5 Solid contaminant code

The preferred method of quoting the number of solid contaminant particles in a sample is the use of B.S. 5540: Part 4 - "Method of Defining Levels of Contamination (solid contaminant code)." Equivalent to ISO/DIS 4406.

See Appendix B for General Contaminant Considerations.

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3.6 Element protection

Consideration shall be given to protecting the element against collapse or burst from high pressure build-up. This is normally provided for by some form of relief or bypass valve. Careful attention should be paid to bypass valve performance, particularly under cold start conditions, when bypassing could leave downstream components unprotected for long periods and such conditions should be avoided.

If for any reason a bypass valve is not used then the designer must ensure that the collapse strength of the chosen element is commensurate with the system operating pressure.

3.7 Pre-filtering

Consideration shall be given to a means of pre-filtering fluid used for filling and replenishing systems, to reduce contamination from external sources. This can be achieved in a number of ways; for example filling using a return line filter, using an off-line filter or with a portable off-line filtration unit where oil is pumped into the reservoir through self sealing couplings.

3.8 Breathers and breather bags

The fitting and siting of breathers is particularly important in systems where large fluid displacements are likely to occur.

Where working conditions may give rise to abnormal airborne contaminants the designer should consider the need to use breather bags instead of ordinary breather filters.

3.9 Flushing

The aim of flushing is to remove contamination from the inside of pipes and components which may be introduced during assembly. It is imperative that the fluid is adequately cleaned before the system is operated under full load. Omission or curtailment of this initial clean up can lead to rapid wear of components, malfunction and breakdown.

A. H. E. M. publication P9 should be referred to for further information and guidelines for flushing hydraulic systems.

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4 Miscellaneous design considerations

4.1 Reservoir

When considering the capacity of the reservoir, allowance should be made for any lateral /longitudinal tilt (e. g. track cant, etc.) , and system surges. The designer should also ensure that all reservoir outlets are submerged during such conditions.

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Part B General maintenance requirements

1 Contamination control

1.1 During repairs/renewing components

1.1.1 General

Careful attention is required to ensure that all component parts of a hydraulic system are supplied and assembled in a clean condition to promote trouble free service.

1.1.2 Components

All components including manifold blocks should be supplied with all openings sealed and surfaces coated with an inhibitive preservation fluid. Seals should only be removed prior to assembly and then care should be taken to ensure that dirt does not enter the openings.

Care should be taken to ensure removal of embedded abrasive compounds, which are residue from manufacturing processes. Such contamination occurs particularly during the manufacture of cylinders.

1.1.3 Pipes

All pipework should be free from scale, rust, flux etc. Fabricated pipes and fittings should be thoroughly blown down to remove loose scale, weld spatter, dirt or sand and cleaned to remove dirt paint and grease by submersion in hot alkaline solution or other recognised process. Mill scale should be removed by pickling. The pipes and fittings should then be thoroughly dried and then coated with a suitable rust preventative which will be readily soluble in the flushing fluid. Finally, all openings should be closed to prevent the entry of foreign matter and excessive moisture.

1.1.4 Reservoirs

If the reservoir was not supplied already cleaned and painted then it should be thoroughly cleaned prior to assembly by effective and safe methods. Before treatment, the inside surfaces should be wiped clean with lint free cloth and all loose dirt should be removed. If internal surfaces are to be left unpainted they should be coated with a soluble rust preventative. If internal surfaces are to be painted then the integrity of the process and finish must be compatible with the fluid and working environment. Finally, all openings should be sealed until ready for assembly.

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1.1.5 Hose assemblies

Prior to fitting a replacement hose assembly it shall have been subjected to a static pressure test of 1.5 times the nominal working pressure.

Storage of hoses shall be avoided wherever possible, however, where hose assemblies are stored as necessary spares, the considerations laid down in B.S. 5244: 1986 with regard to storage and retesting shall be complied with.

1.2 Flushing

1.2.1 General

Flushing is a procedure which is vital to the satisfactory operation and life of a hydraulic system. It is imperative that the fluid is adequately cleaned before the system is operated under full load. The aim of flushing is to remove contamination from the inside of pipes and components which may be introduced during assembly. Omission or curtailment of this initial clean up can lead to rapid wear of components, malfunction and breakdown.

A. H. E. M. Publication P9 should be referred to for further information and guidelines for the flushing of hydraulic systems.

1.2.2 Maintenance

Flushing of systems and sub-systems should be carried out in service after component failure or replacement and when systems have been broken into for modifications or repairs. The laid down procedure should be used and particular attention should be given to requirements for bridging restrictions and sensitive components.

1.3 Maintenance control

1.3.1 General

The end user is responsible for ensuring that adequate servicing facilities are available and that routine maintenance is carried out. Where maintenance manuals and other information is provided, the laid down procedures must be followed.

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