BS ISO 16431:2012

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Hydraulic fluid power — System clean-up procedures and verification of cleanliness of assembled systems

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National foreword

This British Standard is the UK implementation of ISO 16431:2012. It supersedes PDISO/TS16431:2002 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee MCE/18/-/6, Contamination control.

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.

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Hydraulic fluid power — System clean-up procedures and verification of cleanliness of assembled systems

Transmissions hydrauliques — Systèmes assemblés — Procédures de dépollution d'un système et vérification de sa propreté

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Foreword

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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 16431 was prepared by Technical Committee ISO/TC 131, *Fluid power systems*, Subcommittee SC 6, *Contamination control*.

This first edition of ISO 16431 cancels and replaces ISO/TS 16431:2002, which has been technically revised.

Introduction

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

The initial cleanliness level of a hydraulic system can affect its performance and useful life. Unless removed, contaminants present after manufacture and assembly of a system can circulate through the system and cause damage. To limit such damage, the fluid and internal surfaces of the hydraulic fluid power system must be cleaned to an acceptable level.

While this International Standard describes a clean-up procedure that uses filters after final assembly of the system, this practice is not a substitute for the use of good practices to achieve and maintain cleanliness prior to final assembly.

INTERNATIONAL STANDARD ISO 16431:2012(E)

Hydraulic fluid power — System clean-up procedures and verification of cleanliness of assembled systems

1 Scope

This International Standard defines methods

a) to measure the cleanliness of a fluid in an assembled hydraulic fluid power system,

b) to verify a required system cleanliness upon release of the system from the production area, and

c) if needed, to clean the system to the required cleanliness level.

The clean-up procedure specified in this International Standard is not intended to replace proper system flushing procedures; see ISO 23309 for a system flushing procedure. Components and parts used in such systems should be clean prior to assembly; see ISO 18413 for guidance.

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 3722, *Hydraulic fluid power — Fluid sample containers — Qualifying and controlling cleaning methods*

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

ISO 4407, *Hydraulic fluid power — Fluid contamination — Determination of particulate contamination by the counting method using an optical microscope*

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

ISO 11500, *Hydraulic fluid power — Determination of the particulate contamination level of a liquid sample by automatic counting using the light extinction principle*

ISO 21018-1, *Hydraulic fluid power — Monitoring the level of particulate contamination of the fluid — Part 1: General principles*

3 Terms and definitions

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

3.1
clean-up filter
filter with a high efficiency, used in place of the system filter during the test procedure specified in this International Standard, to obtain the required cleanliness level

3.2
auxiliary filter system
filter or other filtration device that is externally mounted and connected to the assembled fluid power system for the purpose of providing fluid filtration, which is then removed from the system after verification of the system's cleanliness

3.3
particle count analysis
process using automatic particle counters or other such approved methods to measure the size distribution of particles and number of particles in a given sample volume of fluid at a given time

3.4
on-line analysis
analysis performed on fluid supplied directly to the instrument by a continuous line from the hydraulic system

3.5
off-line analysis
analysis performed on a fluid sample by an instrument that is not directly connected to the hydraulic system

3.6
required cleanliness level
RCL
liquid cleanliness level required for a system or process

NOTE This is expressed in accordance with ISO 4406.

4 Test equipment

4.1 Fluid line sampler that conforms to ISO 4021. In the absence of such a sampler, a **pressure measuring port** may be used, as long as the sample is taken from the main flow.

4.2 Fluid sample containers qualified in accordance with ISO 3722. If on-line analysis is used, such sample containers are not required.

4.3 Particle counting or monitoring equipment capable of counting and sizing solid contaminant particles. Automatic particle counters (APCs) used in accordance with ISO 11500, microscopic or image analysis equipment used in accordance with ISO 4407 or a particulate contamination monitor used in accordance with ISO 21018-1 meet the requirements of this subclause.

4.4 Clean-up filter or **auxiliary filter system** and a **means** of circulating the system fluid through the filter.

These items are necessary only if the required cleanliness level is not achieved.

5 Sampling

CAUTION — Sampling from high pressure lines can be dangerous. A means of dissipating the pressure shall be provided.

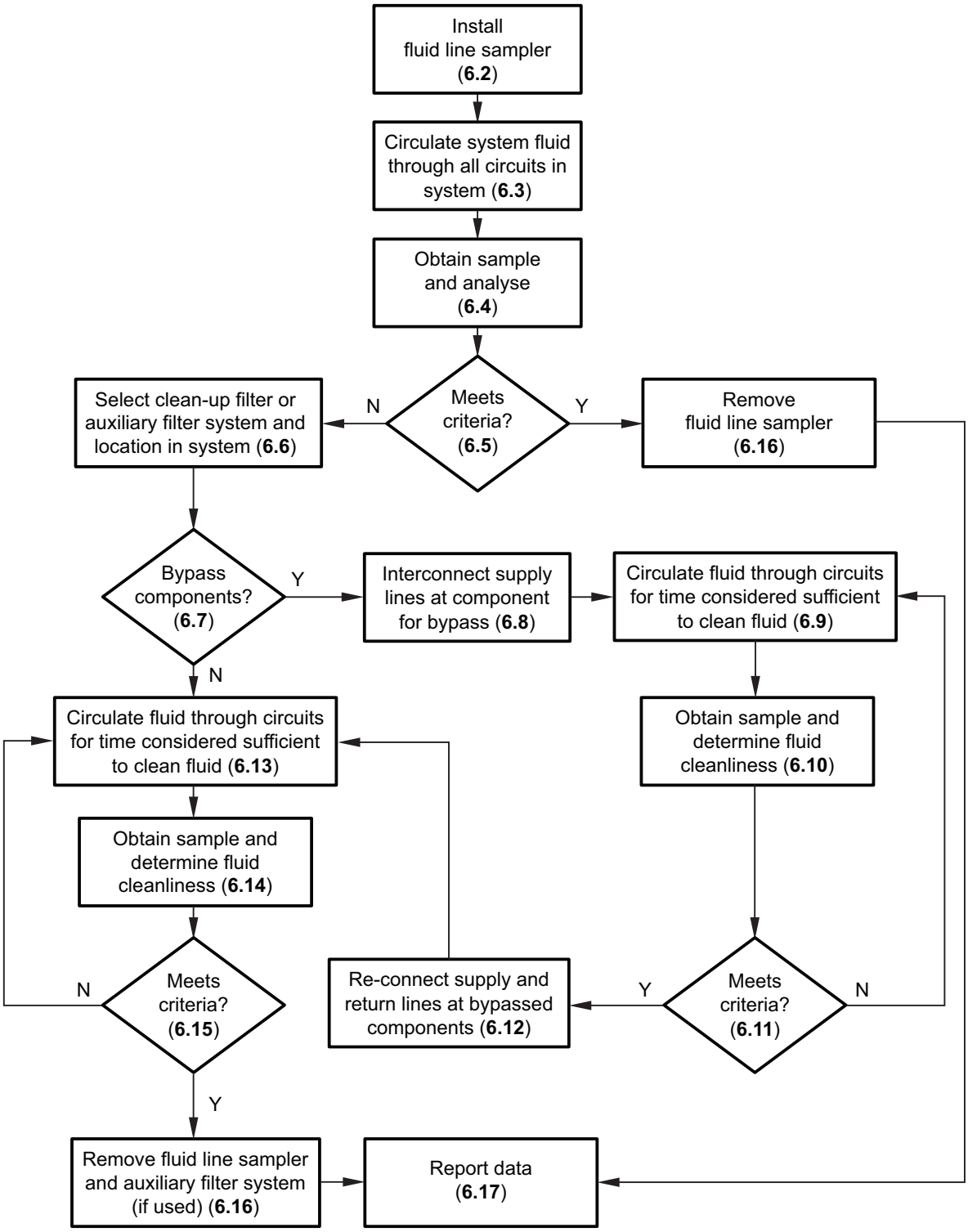
Obtain samples in accordance with ISO 4021 where possible; for other cases, see 4.1. Adequately flush the sampling supply line of residual particles to ensure that a representative fluid sample can be obtained.

Samples shall not be taken from the system's reservoir unless there are no alternative sampling points available.

6 Test procedure

6.1 The procedures contained in this clause shall be considered as the minimum required and might not give the cleanliness required for all systems, especially those with large pipe runs and complex circuitry. For such systems, it can be necessary to use more specific cleaning procedures.

See Figure 1 for a flowchart (block diagram) that illustrates the procedure for verifying the cleanliness of an assembled hydraulic system. Figure 1 also provides the numbers of subclauses corresponding to each step in the procedure.



NOTE Numbers in parentheses refer to the corresponding subclauses.

Figure 1 — Flowchart (block diagram) of procedure for system clean-up and for verifying the cleanliness of an assembled hydraulic system

6.2 If a fluid line sampler is not already installed on the system, install one and record its location. If an automatic particle counter or fluid contamination monitor is used, connect it with a line to the fluid line sampler. The fluid line sampler should be located upstream of the system filter whenever possible.

NOTE Sampling upstream of the filter facilitates the measurement of the highest contamination level in the system and provides better indication of the progress of cleaning.

6.3 Circulate the system fluid at the maximum working flow rate through all circuits of the system until the manufacturer's operating conditions are achieved and all components of the system have been exercised. As an option, separate cleaning filters and procedures may be used prior to circulating the system fluid; see 6.6 through 6.12.

6.4 Determine the fluid cleanliness by either

a) obtaining a representative bottle fluid sample and performing a particle count analysis in accordance with ISO 11500 or ISO 4407, or

b) performing on-line contamination monitoring in accordance with ISO 21018-1.

On-line instruments used should be checked to ensure that they are detecting only actual particulate contamination and not air bubbles, water droplets or additives. Record the data. Evaluate the results of the analysis in accordance with the requirements of Clause 7.

6.5 If the requirements of Clause 7 are not met and additional cleaning operations are required, proceed to 6.6. If the requirements of Clause 7 are met, proceed to 6.16.

6.6 Select a clean-up or auxiliary filter system and install it in an appropriate location in the system in accordance with the system manufacturer's recommended procedures (e.g. at the outlet of the main system pump; in the existing filter housing; or at an external connection to the reservoir).

6.7 Determine if any components should be temporarily bypassed. If no components are to be bypassed, proceed to 6.13.

6.8 Bypass any component as required by interconnecting supply and return lines at the component.

NOTE Addition or removal of a line or component, addition of fluid or other disruption of the system can add contamination to the system.

6.9 Circulate the system fluid at the maximum working flow rate through all circuits of the system by operating the system for a time considered sufficient to clean the system fluid to a cleanliness level that meets the requirements of Clause 7.

6.10 Determine the fluid cleanliness by either

a) obtaining a representative bottle fluid sample and performing a particle count analysis in accordance with ISO 11500 or ISO 4407, or

b) performing on-line contamination monitoring in accordance with ISO 21018-1.

Record the data. Evaluate the results of the analysis in accordance with the requirements of Clause 7.

6.11 If the requirements of Clause 7 are not met and additional cleaning operations are required, repeat the procedures specified in 6.9 and 6.10. If the requirements of Clause 7 are met, proceed to 6.12.

If the agreed-upon system cleanliness level cannot be achieved in an acceptable period of time, contamination control practices used in the production of system parts and components should be reviewed.

6.12 Reconnect the supply and return lines of any bypassed components.

6.13 Circulate the system fluid at the maximum working flow rate through all circuits of the system by operating the system for a time considered sufficient to clean the system fluid to a cleanliness level that meets the requirements of Clause 7.

6.14 Determine the fluid cleanliness by either

a) obtaining a representative bottle fluid sample and performing a particle count analysis in accordance with ISO 11500 or ISO 4407, or

b) performing on-line contamination monitoring in accordance with ISO 21018-1.

Record the data. Evaluate the results of the analysis in accordance with the requirements of Clause 7.

6.15 If the requirements of Clause 7 are met, proceed to 6.16. If the requirements of Clause 7 are not met and further cleaning operations are required, repeat the procedures specified in 6.13 and 6.14.

6.16 If necessary, remove the connection lines between the fluid line sampler and any automatic particle counter or fluid contamination monitor and, if used, the auxiliary filter system.

6.17 Report final data as required in Clause 8.

7 Criteria for acceptance

The system shall be accepted if the cleanliness level of the fluid in the assembled hydraulic system at the time the system is released from the production area is equal to or cleaner than the cleanliness level agreed upon by the supplier and purchaser of the system.

8 Test report

The test report on the cleanliness level of an assembled hydraulic fluid power system shall contain at least the following information:

— date that the test was performed;

— identification number (e.g. serial number) of the system under test;

— measured cleanliness level of the assembled system upon release from the production area;

— sampling method used;

— any components bypassed during the procedure;

— operating conditions (temperature, pressure, fluid type and viscosity, and all other conditions of the operating system as requested by the purchaser);

— contamination analysis, including method of analysis and mode of analysis (e.g. on-line or off-line) .

An example of a test form is given in Annex A. An example of a completed test report for recording this information is given in Annex B.

9 Identification statement (reference to this International Standard)

Use the following statement in test reports, catalogues and sales literature when electing to comply with this International Standard:

“Method of verifying the cleanliness of an assembled hydraulic system in accordance with ISO 16431, *Hydraulic fluid power — System clean-up procedures and verification of cleanliness of assembled systems*.”

Annex A
(informative)

Form for reporting the verification of the cleanliness level of an assembled hydraulic system

Date test performed:	
Identification number (e.g. serial number) **of the system under test:**	
Sampling method used:	
Any components bypassed during the procedure:	
Operating conditions:	
Fluid temperature:	°C
Operating pressure in the system:	MPa (bar)
Fluid type and viscosity:	
Other (as requested by the purchaser):	
Particulate contamination analysis	
Method of analysis:	☐ ISO 11500 ☐ ISO 4407 ☐ ISO 21018-X[a] ☐ Other: _____
Mode of analysis:	☐ on-line ☐ off-line
Measured cleanliness level of assembled system upon release from the production area (reported in accordance with the relevant standard for the method used):	
[a] X refers to the specific part of ISO 21018 used.	

Annex B
(informative)

Example of a completed form for reporting the verification of the cleanliness level of an assembled hydraulic system

Date test performed:	14 May 2011
Identification number (e.g. serial number) **of the system under test:**	689-agr-2348
Sampling method used:	On-line particulate contamination monitor
Any components bypassed during the procedure:	No
Operating conditions:	
Fluid temperature:	82 °C
Operating pressure in the system:	1 MPa (10 bar)
Fluid type and viscosity:	Mineral oil, ISO VG 32
Other (as requested by the purchaser):	None
Particulate contamination analysis	
Method of analysis:	☐ ISO 11500 ☐ ISO 4407 ☑ ISO 21018-3 ☐ Other: _____
Mode of analysis:	☑ on-line ☐ off-line
Measured cleanliness level of assembled system upon release from the production area (reported in accordance with the relevant standard for the method used):	—/14/11, in accordance with ISO 4406

Bibliography

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

[2] ISO 11171, *Hydraulic fluid power — Calibration of automatic particle counters for liquids*

[3] ISO 18413, *Hydraulic fluid power — Cleanliness of parts and components — Inspection document and principles related to sample collection, sample analysis and data reporting*

[4] ISO 21018-3, *Hydraulic fluid power — Monitoring the level of particulate contamination of the fluid — Part 3: Use of the filter blockage technique*

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

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