SLOVENSKI STANDARD
SIST ISO 11943:2000

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Fluidna tehnika - Hidravlika - Postopki za samodejno ģtetje delcev v tekoļ inah med pogonom - Metode kalibriranja in validacije

Hydraulic fluid power -- On-line automatic particle-counting systems for liquids -- Methods of calibration and validation

Transmissions hydrauliques -- Systèmes de comptage automatique en ligne de particules en suspension dans les liquides -- Méthode d'étalonnage et de validation

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INTERNATIONAL STANDARD

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Hydraulic fluid power — On-line automatic particle-counting systems for liquids — Methods of calibration and validation

Transmissions hydrauliques — Systèmes de comptage automatique en ligne de particules en suspension dans les liquides — Méthode d'étalonnage et de validation

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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 3.

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.

International Standard ISO 11943 was prepared by Technical committee ISO/TC 131, *Fluid power systems*, Subcommittee SC 6, *Contamination control and hydraulic fluids*.

Annexes A, B and C of this International Standard are for information only.

Introduction

In hydraulic fluid power systems, power is transmitted and controlled through a fluid under pressure within an enclosed circuit. The fluid is both a lubricant and a power-transmitting medium.

Reliable system performance requires control of the fluid medium. Qualitative and quantitative determination of particulate contaminant in the fluid medium requires precision in obtaining the sample and determining the size and distribution of the contamination.

Automatic particle counters are an accepted means for determining the size and distribution of particulate contamination in fluids. Individual instrument accuracy is established through calibration.

Automatic particle counters are being utilized on-line to eliminate the need for sample containers, to provide increased accuracy, and to provide for a more rapid access to particle count information. This International Standard establishes guidelines for calibration and validation of on-line automatic particle counters.

Hydraulic fluid power — On-line automatic particle-counting systems for liquids — Methods of calibration and validation

1 Scope

This International Standard establishes a calibration and validation process for the use of on-line, automatic particle counting of suspended particles in liquids. A primary use is in the Multi-pass filter test ISO 16889.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 1000:1992, *SI units and recommendations for the use of their multiples and of certain other units*.

ISO 1219-1:1991, *Fluid power systems and components — Graphic symbols and circuit diagrams — Part 1: Graphic symbols*.

ISO 4021:1992, *Hydraulic fluid power — Particulate contamination analysis — Extraction of fluid samples from lines of an operating system*.

ISO 5598:1985, *Fluid power systems and components — Vocabulary*.

ISO 11171:—[1)], *Hydraulic fluid power — Calibration of automatic particle counters for liquids*.

ISO 12103-1:1997, *Road vehicles — Test dust for filter evaluation — Part 1: Arizona test dust*.

ISO 16889:—[2)], *Hydraulic fluid power — Filters — Multi-pass method for evaluating filtration performance of a filter element*.

3 Terms and definitions

For terms and definitions of terms, see ISO 5598.

4 Units of measurements

The international system of units (SI) is used in accordance with ISO 1000.

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1) To be published. (Revision of ISO 4402:1991)

2) To be published. (Revision of ISO 4572:1981)

Throughout this International Standard, the use of µm(c) means that particle size measurements are carried out using an automatic particle counter which has been calibrated in accordance with ISO 11171.

5 Prerequisite

It is assumed that users of this procedure are competent in the operation of their particular particle counter and filter test equipment. It is also important that proper sample handling techniques be utilized throughout the procedure.

6 Test equipment

6.1 Automatic particle counter(s) or **particle counter with two independent sensors for liquids**.

6.2 Calibration supplies, in accordance with ISO 11171.

6.3 ISO medium test dust (ISO MTD) in accordance with ISO 12103-1, category A3, dried at 110 °C to 150 °C for at least 1 h and for use in the test system, mixed in the test fluid, mechanically agitated, then dispersed ultrasonically with a power density of 3 000 W/m^2 to 10 000 W/m^2.

NOTE This standard test dust is used in ISO 16889 for filter test purposes. For availability of ISO MTD, contact the ISO secretariat service or national members of ISO.

6.4 Test fluid, as specified in ISO 16889.

6.5 On-line sample preparation equipment, for mixing and supplying secondary calibration and validation fluid, comprising

a) a reservoir, pump, fluid conditioning apparatus and instrumentation which are capable of meeting the validation requirements of clause 9;

b) a clean-up filter capable of providing an initial fluid contamination level less than 5 particles greater than 5 µm(c) per millilitre;

c) a configuration which will not alter the contaminant distribution over the anticipated test duration (refer to ISO 16889);

d) fluid sampling sections in accordance with ISO 4021;

e) a configuration which will supply contaminated fluid to the particle counters under constant flow and temperature within the limits of Table 1.

NOTE 1 A Multi-pass test rig (see ISO 16889) can be used provided it has been validated per clause 9 of this procedure.

NOTE 2 An alternative typical configuration which has proved to be satisfactory is given in annex A.

6.6 Hydraulic circuit, containing dilution equipment, if required, for on-line counter adaptation to the Multi-pass test stand.

For typical hydraulic circuit configurations which have proven to be satisfactory refer to annex B.

7 Accuracy of measuring equipment and test conditions

7.1 Utilize measuring equipment with an accuracy within the limits in Table 1.

Table 1 — Measuring equipment accuracy and test conditions

Test condition	SI Unit	Instrument accuracy (± of reading)	Allowed test condition variation
Flow	l/min	0,5 %	2 %
Kinematic viscosity	mm^2/s	1 %	2 %
Pressure	Pa (bar)	1 %	2 %
Temperature	°C	0,5 °C	1 °C
Time	s	0,05 s	0,1 s
Volume	l	0,5 %	1 %
Mass	g	0,1 mg	1 %

CAUTION — Maintaining the accuracy of test conditions to within the limits of Table 1 does not imply that by so doing the validation limits will be satisfied. It has been proven that the most useful way in attaining the validation requirements is by maintaining the accuracy of test conditions given in Table 1 along with using the proper particle counting procedures, etc.

8 Off-line calibration procedure

8.1 Conduct a sizing calibration on particle counters when new or after major service as suggested by the particle counter manufacturer or in accordance with ISO 11171.

8.2 Use the procedures specified in ISO 11171 to determine particle concentration limits of each particle counter and sensor or use the manufacturer's recommended levels obtained in a similar manner.

9 Validation of on-line sample preparation equipment and determination of secondary calibration standard (see Figure 1)

9.1 When two counters (sensors) are to be used, the procedure described in this clause need only be performed using one counter and sensor.

9.2 Use one particle counter and sensor calibrated in accordance with 8.1 and set to the cumulative mode and at least six different threshold settings over the particle size range of interest.

9.3 Adjust total fluid volume, expressed in litres, in sample preparation equipment to the desired level and measure within ± 1 %. Maintain fluid viscosity at (15 ± 0,3) mm^2/s.

9.4 Use a clean-up filter to provide an initial fluid contamination level less than 5 particles greater than 5 µm(c) per millilitre.

9.5 Determine the contaminant concentration to be used for calibration and verification. The dust concentration should produce a maximum particle count at the lowest particle size of approximately 50 % of the particle counter concentration limit determined in 8.2.

9.6 Add the required quantity of ISO MTD, prepared in accordance with 6.3, to the reservoir and allow to circulate for approximately 15 min. Record the lot number of the ISO MTD.

9.7 Start the test by conducting on-line automatic particle counts (sample volumes of 25 ml are recommended) at 2 min intervals for 1 h or 30 intervals spaced evenly throughout the longest period of time that the system will be used.

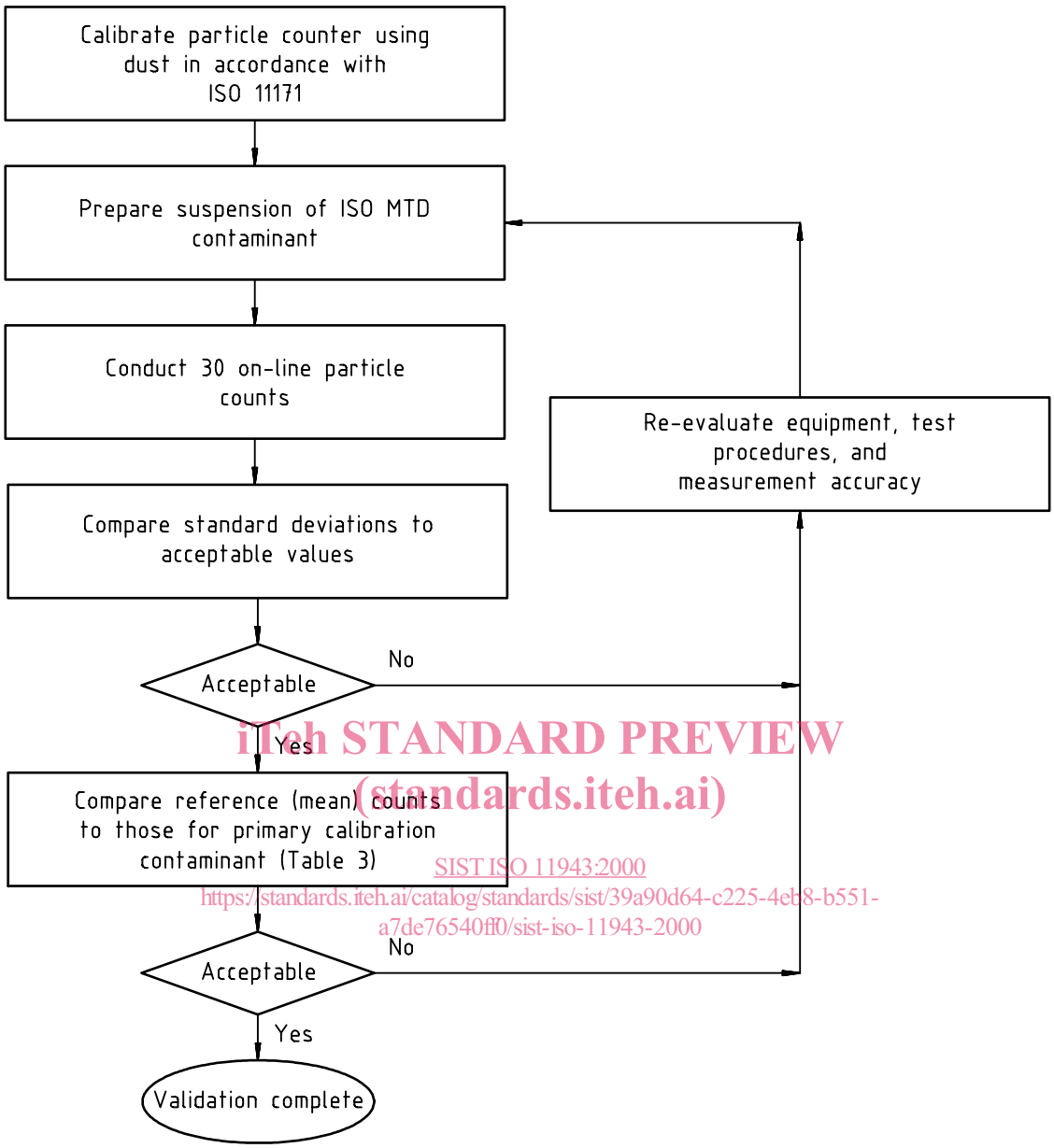

Figure 1 — Flowchart for the validation procedure of on-line sample preparation equipment and determination of secondary calibration standard

9.8 Complete Table 2 by filling in the required data for each of the raw particle counts observed. For each particle-size threshold setting, calculate the mean, $\bar{x}$, and also the standard deviation, σ, of all the counts using the following equation:

$$\sigma = \sqrt{\frac{n\sum_{i=1}^{n}\left(x_i^2\right) - \left(\sum_{i=1}^{n} x_i\right)^2}{n(n-1)}}$$

where

x_i is the particle concentration for each threshold setting for sample i;

n is the total number of particle counts taken.

Table 2 — Secondary calibration dust data sheet

ISO MTD lot no.:_____ Concentration:_____ mg/l Particle count volume:_____ml

Operator:_____ Date:_____ Particle counter model:_____

Particle counter serial no.:_____Sensor model:_____

Sensor serial no.:_____ ISO 11171 primary calibration date:_____

	Number of particles						
Size, µm(c) >							
Count 1							
Count 2							
Count 3							
Count 4							
Count 5							
Count 6							
Count 7							
Count 8							
Count 9							
Count 10							
Count 11							
Count 12							
Count 13							
Count 14							
Count 15							
Count 16							
Count 17							
Count 18							
Count 19							
Count 20							
Count 21							
Count 22							
Count 23							
Count 24							
Count 25							
Count 26							
Count 27							
Count 28							
Count 29							
Count 30							
Mean							
σ							
Acceptable σ							

9.9 Calculate the acceptable standard deviation for each particle size by using the following equation:

$$\sigma_{\text{acceptable}} = 2\sqrt{\bar{x} + 0{,}0004\,\bar{x}^2}$$

NOTE This acceptable standard deviation is based on 2 times the average standard deviation obtained in the round robin study (see annex C).

9.10 Accept the validation if the standard deviation for each particle size is less than or equal to the acceptable standard deviation for that size, then proceed to 9.13.

9.11 If the standard deviation for a given particle size exceeds the acceptable standard deviation, then re-evaluate the sample preparation equipment and procedures, the flow rates and particle count volumes for the on-line particle equipment. Take appropriate action and repeat the procedure from 9.3 to 9.10.

9.12 Calculate the particle concentration per ml for each particle size threshold setting by dividing the mean count by the fluid volume counted.

9.13 Convert the counts obtained in 9.12 to a number per µg (number per ml for 1 mg/l) by dividing by the sample concentration, in milligrams per litre. Record these reference counts in column 3 of Table 3.

9.14 Record, in column 2 of Table 3, the particle count (number per microgram) for the contaminant used for the primary calibration in 8.1.

9.15 Calculate and record, in column 4 of Table 3, the acceptable calibration limits for each particle size using the following equation:

$$\text{Calibration limit} = 0{,}37\,(\text{calibration count in column 2 of Table 3})^{0{,}85}$$

NOTE These calibration limits for agreement are based on a 5 % variation in particle size together with 1 σ (Poisson distribution) as determined by the round robin study conducted (annex C).

9.16 Accept the equipment validation and reference counts if the reference counts are equal to the counts for primary calibration contaminant given in column 2 of Table 3 within 1,3 times the limits in column 4 of Table 3.

NOTE These reference counts define the particle size distribution of the secondary calibration contaminant (the specific lot number used in 9.5) and these counts will be used in clauses 10 and 11 for secondary calibration and verification.

9.17 When multiple counters or sensors are being used, calculate the allowable variation between sensors or counters for each particle size based on the following equation, and enter in column 5 of Table 3:

$$\text{Allowable variation} = 0{,}6 + 0{,}05\,(\text{calibration count in column 2 of Table 3})$$

The maximum allowable particle count difference between counters shall be less than 10 % of the mean particle count.

NOTE The variation between counters is based on 2,5 σ (Poisson distribution) as determined by the round robin study.

10 On-line secondary calibration and verification procedure (see Figure 2)

10.1 Perform an on-line calibration verification after each primary calibration and at a maximum of six-month intervals or when particle count discrepancies are suspected or observed.

NOTE When two particle counters (sensors) are being used, calibration and verification should be carried out on one counter (sensor) using the procedures in 10.1 to 10.10 then the second counter (sensor) should be adjusted to match the first in accordance with 10.11.