BRITISH STANDARD

BS EN
12483:1999

Liquid pumps — Pump units with frequency inverters — Guarantee and compatibility tests

The European Standard EN 12483:1999 has the status of a British Standard

ICS 23.080

National foreword

This British Standard is the English language version of EN 12483:1999

The UK participation in its preparation was entrusted to Technical Committee MCE/6, Pumps and pump testing, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

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Summary of pages

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Liquid pumps — Pump units with frequency inverters — Guarantee and compatibility tests

Pompes pour liquides— Groupes de pompage équipés d'un variateur de fréquence — Essais de garantie et de compatabilité

Flüssigkeitspumpen — Pumpenaggregate mit Frequenzumrichter — Garantie- und Verträglichkeitsprüfungen

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CEN

European Committee for Standardization
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Europäisches Komitee für Normung

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Contents

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 197, Pumps, the Secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 1999, and conflicting national standards shall be withdrawn at the latest by November 1999.

This standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

Several standards define the acceptance testing of liquid pumps, and the means for the verification of the guarantee performance of the pump.

Electric motors for alternating current operate at speeds which are dependent upon the number of poles, and the power line frequency. By means of an inverter, the frequency can be varied and a pump operated over a range of speed related duty points. The design of the inverter requires special care in selecting and matching the electric motor and the test instrumentation to be used during the tests, as well as in analysing the readings taken, in order for a true assessment to be made of the pump performance and of the compatibility of the elements making up the unit.

1 Scope

This European Standard defines the procedures to be used for the verification of the guaranteed performance of a pump when supplied together with a motor and an inverter to control operating speed. It defines also the method of demonstrating the compatibility of the elements forming the pump unit. The application of this standard should be by agreement between the purchaser and the supplier.

This European Standard applies to liquid pumps driven by electric motors controlled by non-integral variable speed inverter systems. It does not apply to a pump unit comprising a pump, a motor, and inverter circuits forming an integrated whole, nor where these items are supplied as individual items to be installed together on site, nor where the items are the subject of other standards.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

ISO 5198:1995, *Centrifugal, mixed flow and axial pumps — Code for hydraulic performance tests — Precision grade.*

prEN ISO 9906:1995, *Rotodynamic pumps — Code for hydraulic performance tests for acceptance — Grades 1 and 2.*
(ISO/DIS 9906:1995)

3 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply.

3.1
frequency inverter (or inverter)
electronic device for varying the frequency of an electric supply

For the purposes of this standard, the device will be separate from the pump but is to be supplied as part of the pump unit.

3.2
compatibility test
procedure for functional testing to demonstrate that all elements of the pump/motor/inverter system function together smoothly and free from difficulties over the intended operating range

3.3
guarantee test
procedure for the verification of the guaranteed performance of the pump/motor/inverter system at one or more duty points

3.4
overall system
arrangement comprising the pump, driver, and inverter complete with all auxiliary items essential for operating the pump at variable speeds

4 Testing arrangements

The arrangements for the tests, the test conditions and the instrumentation shall be in conformance to a standard such as prEN ISO 9906:1995 or ISO 5198 unless otherwise agreed between the purchaser and the manufacturer/supplier.

For tests conforming to prEN ISO 9906:1995, care shall be taken to ensure that the instrumentation makes allowances for the presence of distortion and harmonics, etc. It is recommended that the electrical power measurement apparatus meets the following requirements:

- a system involving the measurement of power in each phase simultaneously;
- true RMS readings;
- crest factor to be not less then 3;
- frequency range to be not less than 20 kHz.

For tests using the thermodynamic method conforming to ISO 5198, care shall be taken to ensure that the head generated by the pump falls within the band of accepted accuracy. This is achieved by relating the generated head to the uncertainties of the differential temperature measurement in mK as set out in the Table 1.

Table 1 — The minimum value of total head related to the uncertainties of temperature measurements

Differential temperature measurement uncertainty	mK	1	2	5	10
For pump efficiency accurate to ±5 %, minimum total head	m	10	20	50	100
For pump efficiency accurate to ±2,8 %, minimum total head	m	25	50	125	250

5 Test procedures

5.1 The guarantee test

The test is carried out in two stages: the first stage establishes the performance of the pump without the influence of the inverter, and the second stage identifies any modified performance arising from using the inverter, and allows the calculation of the effective efficiency of the inverter.

5.1.1 *Testing the pump*

The pump shall be installed for the test without the inverter in the electric supply line using either the contract motor or a suitable substitute motor.

For rotodynamic pumps, if the specified duty points are at a speed different from nominal speed or for liquid characteristics different from those of the test liquid, they shall be corrected to duties at the speed of the test motor and to the characteristics of the test liquid by the application of the Affinity Laws as described in prEN ISO 9906:1995. Care shall be taken to avoid overloading any element of the test arrangement as a result of operating at the corrected conditions.

For positive displacement pumps, the correction to a duty at a nominal speed shall be made whilst keeping the load on the motor constant by, for example, changing the outlet pressure.

For tests conforming to prEN ISO 9906:1995, the rate of flow, head, speed, and power absorbed shall be measured and recorded with the pump operating at (or close to) each specified or corrected duty point, and the motor efficiency obtained from calibration or from the summation of losses method or from consultation with the motor supplier.

For tests conforming to the thermodynamic method in ISO 5198 readings of the differential head and temperature rise shall be measured and recorded with the pump operating at (or close to) each specified or corrected duty point.

The test values shall be compared with the corrected guarantee values and the pump performance shall be considered to have been verified if the test values fall within the acceptance limits defined in prEN ISO 9906:1995 or as otherwise agreed between the purchaser and the supplier. The readings and the results shall be recorded.

5.1.2 *Testing the inverter*

If a substitute motor has been used for testing the pump it should be replaced by the contract motor and the inverter shall be introduced into the test arrangement without any change to other items of equipment. The pump shall be operated at or close to each of the specified duty points, and the inverter adjusted to give the same speeds as were achieved for testing the pump. The flow rate, or if appropriate the liquid temperature rise across the pump, head, and the power absorbed at the electrical input to the inverter, shall be measured and recorded.

The overall system efficiency shall be calculated as:

$$\text{overall system efficiency, } h_{gr}, \% = \frac{\text{power output from the pump in kW}}{\text{power input to the inventer in kW}} \text{ x } 100$$

The inverter/motor efficiency shall be calculated as:

$$\text{inverter/motor efficiency, } h_{\text{inv.mot.}}, \% = \frac{\text{power output from the motor in kW}}{\text{power input to the inverter in kW}} \text{ x } 100$$

This method allows the calculation of the effective inverter efficiency as follows:

$$\text{effective inverter efficiency, } h_{\text{inv.}}, \% = \frac{\text{inverter/motor efficiency}}{\text{motor efficiency}} \text{ x } 100$$

NOTE 1 The motor efficiency to be used in this calculation should be the value advised by the motor supplier.

NOTE 2 The effective inverter efficiency reached by this method could be different from the inverter efficiency given by the manufacturer of the inverter resulting from different load conditions and the electrical characteristics of other elements of the system.

The overall system efficiency derived from the test results shall be compared with the guarantee value overall system efficiency and its tolerances agreed between the purchaser and the supplier before the commencement of the tests.

5.2 Compatibility test

The test shall be carried out at operating conditions agreed between the purchaser and the supplier. In the absence of specific agreement, the test shall be conducted at a duty falling within the range of duties for which the equipment is being supplied, and preferably within +5 % or –5 % of the flow rate coinciding with the best efficiency of the pump at synchronous speed. Starting from the set conditions the inverter frequency shall be changed steadily to make the pump operate through the agreed range of duty points. The response of the system shall be reproducible and agreed by the purchaser and the supplier to be acceptable taking into account such characteristics as noise, vibration, and electrical phenomena.

Any performance data recorded during the compatibility test cannot be used to accurately determine the pump/motor efficiency.

6 Test report

The verification of the guarantee shall be reported on data sheet (see annex A):

- calculation of equivalent guarantee duty;
- report of test results.

The minimum data to be shown are:

- identification of the pump;
- identification of the motor(s) used for the test;
- identification of the inverter;
- the specified duty point and speed;
- the equivalent duty point at nominal speed;
- the performance results without the use of the inverter;
- the performance results with the use of the inverter.

Annex A (informative)
Example of data sheet for verification of guarantee

Verification of guarantee **Calculation of equivalent guarantee duty**	**Date**

Pump manufacturer's reference	
Customer	
Customer reference	

Pump type	
Motor type/manufacturer	
Inverter type/manufacturer	

Testing standard	

		Specified duty point	Equivalent duty point at nominal speed
Speed	min^{-1}		
Flow	m^3/h		
Head	m		
Pump efficiency	%		
Pump output power	kW		
Pump input power	kW		
Drive losses	kW		
Motor efficiency	%		
Motor input power	kW		
Inverter losses	kW		
Inverter input power	kW		
Overall system efficiency	%		

Notes
1) Ensure that the motor efficiency has been sufficiently derated to take account of harmonic losses caused by the inverter.
2) Ensure that inverter losses take account of all losses e.g.: fans, additional heat losses, etc.
3) Ensure that the motor efficiency when running at any part loading is derated accordingly.
4) If the pump speed at the design duty is below 20 % of the equivalent duty, it should be ensured that the pump efficiency is corrected.

Notes:

Prepared by:	Approved by:

Verification of guarantee **Report of test results**	**Test date**

Pump manufacturer's reference	
Customer	
Customer reference	
Pump type	

Testing standard	

		Specified duty point	Equivalent duty point at nominal speed
Flow	m^3/h		
Head	m		
Speed	min^{-1}		
Guaranteed overall system efficiency	%		

		Test 1	Test 2
Test basis		Power direct from mains supply	Power through inverter
Actual duty flow	m^3/h		
Actual duty head	m		
Pump output power	kW		
Pump input power	kW		
Drive losses	kW		
Pump efficiency	%		
Electrical power input	kW		
Inverter/motor efficiency	%		
Achieved overall system efficiency	%		

Guaranteed overall system efficiency	%	
Achieved overall system efficiency	%	

Pumpset is therefore accepted/rejected

Notes

Tested by:	Witnessed by:

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