
**Geotechnical investigation and
testing — Geohydraulic testing —**

**Part 4:
Pumping tests**

Reconnaissance et essais géotechniques — Essais géohydrauliques —

Partie 4: Essais de pompage

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 182, *Geotechnics*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 341, *Geotechnical investigation and testing*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 22282-4:2012), which has been technically revised.

The main changes compared to the previous edition are as follows:

- editorial changes;
- correction of formulae.

A list of all parts in the ISO 22282 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

General rules on the planning and execution of geohydraulic field tests are covered by ISO 22282-1.

A pumping test consists in principle of:

- drawing down the piezometric surface of the groundwater by pumping from a well (the test well);
- measuring the pumped discharge and the water level in the test well and piezometers, before, during and after pumping, as a function of time.

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Geotechnical investigation and testing — Geohydraulic testing —

Part 4: Pumping tests

1 Scope

This document establishes requirements for pumping tests as part of geotechnical investigation service in accordance with EN 1997-1 and EN 1997-2.

This document applies to pumping tests performed on aquifers whose permeability is such that pumping from a well can create a lowering of the piezometric head within hours or days depending on the ground conditions and the purpose. It covers pumping tests carried out in soils and rock.

The tests concerned by this document are those intended for evaluating the hydrodynamic parameters of an aquifer and well parameters, such as:

- permeability of the aquifer,
- radius of influence of pumping,
- pumping rate of a well,
- response of drawdown in an aquifer during pumping,
- skin effect,
- well storage,
- response of recovery in an aquifer after pumping.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 14688-1, *Geotechnical investigation and testing — Identification and classification of soil — Part 1: Identification and description*

ISO 14689, *Geotechnical investigation and testing — Identification, description and classification of rock*

ISO 18674-4, *Geotechnical investigation and testing — Geotechnical monitoring by field instrumentation — Part 4: Measurement of pore water pressure: Piezometers*

ISO 22282-1, *Geotechnical investigation and testing — Geohydraulic testing — Part 1: General rules*

ISO 22475-1, *Geotechnical investigation and testing — Sampling methods and groundwater measurements — Part 1: Technical principles for the sampling of soil, rock and groundwater*

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 22282-1 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.2 Symbols

Symbol	Designation	Unit
D	drilled diameter of the well	m
d	thickness of the aquifer	m
L	wetted length of screen of the perforated pipe placed in the well	m
Q	flow rate	m ³ /s
Q_d	discharge rate, assessed pumping discharge at the end of the well preparation	m ³ /s
Q_e	discharge rate of the pumping test	m ³ /s
S	storage coefficient	—
T	transmissivity	m ² /s
t	time	s
v	velocity	—
a	slope of the line that characterizes the drawdown in the well	—
b	ordinate at the origin of the line that characterizes the drawdown in the well	—
c	conventional drawdown unit of the preliminary pump discharge	—
d_N	size which may be interpolated from the grading curve, of the square sieve mesh of side d for which the weight percent of undersize is equal to N percent	—
e	distance between the bottom of the well and the surface of the unconfined groundwater at rest in an aquifer	m
Δh	drawdown of the water level in the well	m
$\Delta h'$	drawdown of the water level in the well after 2 h	m
Δh_f	drawdown of the water level in the well, set during the preliminary test and not to be exceeded	m
Δh_{\max}	maximum drawdown of the water level in the well during the pumping test	m

4 Equipment

The following equipment and instruments shall be used to conduct a pumping test:

- a) a test well and piezometers in accordance with ISO 18674-4;
- b) a pump and associated pipework capable of pumping from the test well; the pumps shall be equipped with a suitably long discharge pipe so that the water from the pump is discharged sufficiently far away so that it does not affect the test area; the capacity of the pump shall be sufficient to extract from the well a discharge at least equal to that corresponding to that estimated to achieve the maximum planned drawdown;

NOTE Pumping tests are commonly carried out using electric submersible pumps, installed within the test well. However, depending on conditions, pumping tests can also be carried out using suction pumps located at the surface, airlift equipment, or special dewatering equipment such as well points or eductors.

- c) a system for regulating and measuring the discharge rate (m^3/s); devices for measuring the discharge rate shall be suitably calibrated and shall be accurate for a range of flow rates anticipated during the test;
- d) a system for measuring the water level in the test well and piezometers; the turbulence in the test well caused by pumping shall be considered; the devices shall be capable of measuring water levels over the range of drawdowns anticipated during the test;
- e) a time measuring and/or recording device, reading in seconds.

5 Test procedure

5.1 Test preparation

5.1.1 General

When preparing a pumping test, there are a number of things to investigate and consider in advance, such as:

- basic information on the ground and groundwater conditions according to ISO 22282-1;
- the required drawdown and/or the required discharge rate during the test;
- the discharge point for the pumped water and its location relative to the test well;
- the duration of the test.

5.1.2 Determining the discharge rate for the pumping test

The discharge rate Q_d shall be estimated to ensure that the test well can yield sufficient water, to allow a pump of appropriate capacity to be selected, and to ensure that the discharge can be accepted at the agreed disposal point.

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The discharge rate can be estimated by one or more of the following methods:

- based on the purpose of the test and experience of local conditions;
- by theoretical assessment of the well capacity, according to the method described in [Annex B](#);
- by analysis of information from the preliminary pumping phase, according to the method described in [Annex B](#).

5.2 Arranging the disposal of discharge water

It is presupposed that the disposal of discharge water is in accordance with relevant rules and regulations.

If the discharge water is not disposed of via an engineered sewer network, it shall be disposed of at sufficient distance from the test well that it will not have a significant impact on the observed pattern of groundwater lowering.

5.3 Executing and equipping the well

5.3.1 Design of the test well

The test well shall be designed to satisfy the following criteria (see [Figure 1](#)):

- of sufficient depth to penetrate below the groundwater level in the strata of interest; if the test well does not fully penetrate the aquifer, it shall penetrate the saturated part of the aquifer to a depth of at least 25 times the well screen diameter with a minimum of 3 m;
- of sufficient drilled diameter to accommodate the necessary filter materials and well screen of sufficient diameter to accommodate pumping equipment of adequate capacity to achieve the required discharge rate;
- with sufficient length and capacity of well screen to ensure that the required discharge rate can be achieved;
- to have appropriate filter material to ensure that the discharge water contains an acceptably low sediment content to avoid the risk of pump damage and ground settlement as a result of the removal of fine particles from the soil; where the well is constructed in a stable rock, it may be possible to construct a test well without the need for filter material.

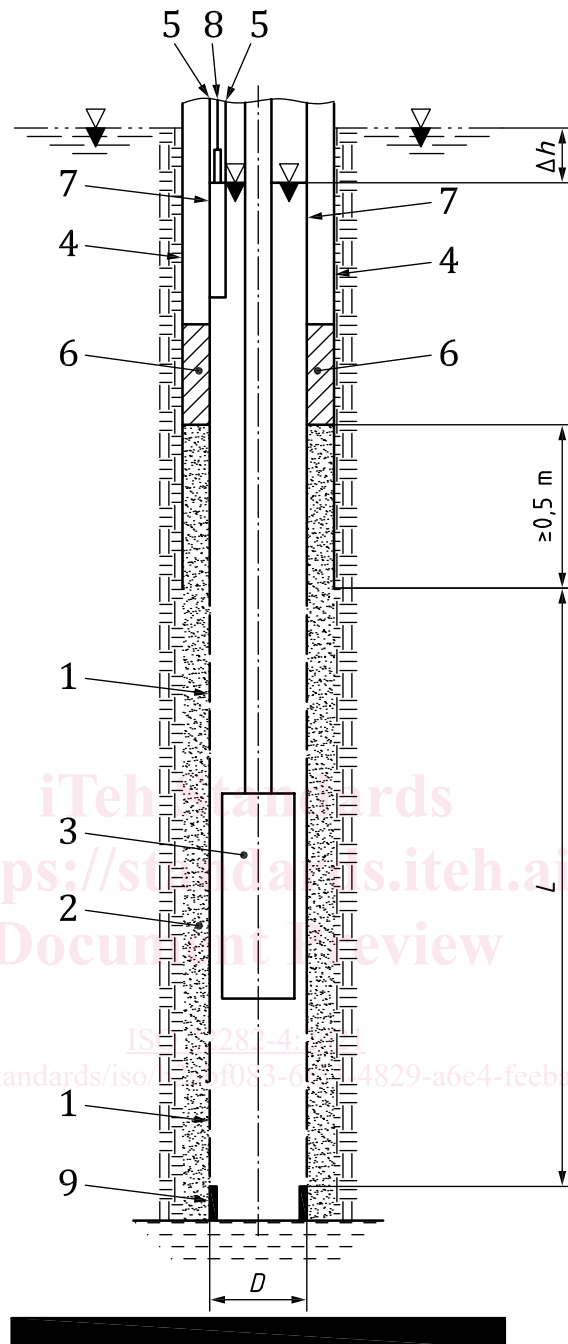
The filter material shall be a highly permeable granular material of closely controlled particle size and be formed of grains of inert minerals in relation to the aquifer groundwater chemistry (e.g. quartz, feldspar). In granular soils, the filter's grading curve shall satisfy the double inequality:

$$5 d_{15 \text{ soil}} \leq d_{15 \text{ filter}} \leq 5 d_{85 \text{ soil}}$$

where d_N designates the characteristic size of the filter or of the ground in place, such that the mass of the soil fraction passing through a sieve with a square mesh of side d represents N % of the total mass of material.

In fine grained soils or where the well screen is equipped with a geotextile mesh designed to act as a filter, the filter material's purpose is to backfill the annular space between the outside of the well screen and the borehole wall. In those circumstances the filter media should be highly permeable coarse sand or fine gravel, with a permeability coefficient at least 100 times that of the soil or rock being tested.

The thickness of the annular space for the filter pack shall be at least 50 mm. The inner diameter of the test well shall be selected according to the purpose.

**Key**

- | | | | |
|---|------------------------------------|-----|--------------------------------------|
| 1 | well screen (slotted tube) | 7 | plain tube |
| 2 | filter material (filter pack) | 8 | device for measuring the water level |
| 3 | submersible pump | 9 | base of the screen |
| 4 | borehole casing | L | filter length |
| 5 | tube for measuring the water level | D | drilled diameter of the well |
| 6 | sealing plug | | |

Figure 1 — Test well equipped for a pumping test — Example