INTERNATIONAL STANDARD

ISO 21413

First edition
2005-10-15

Manual methods for the measurement of a groundwater level in a well

Méthodes manuelles pour le mesurage du niveau de l'eau souterraine dans un puits

Reference number
ISO 21413:2005(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

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 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 21413 was prepared by Technical Committee ISO/TC 113, *Hydrometry*, Subcommittee SC 8, *Ground water*.

Introduction

The measurement of a water level in a well constitutes a data-collection process that provides fundamental information about the status of a groundwater system. Accordingly, measured water levels should be sufficiently accurate and reproducible to meet the needs of most data-collection and monitoring programs. Several manual methods commonly used to collect water-level data in wells employ relatively simple measuring devices such as graduated steel tapes, electric tapes, and air lines. In some cases, water-level measurements are required in flowing wells. The procedures associated with each of these methods are intrinsically different and subject to varying limitations and accuracies. Standardization of these methods would ensure that the procedures and associated equipment used by the international community to collect water-level data in a well are consistent, and that the results can be compared with minimal concern about the relative accuracies and/or the procedures use in collecting the data.

Manual methods for the measurement of a groundwater level in a well

1 Scope

This International Standard develops procedures and prescribes the minimum accuracy required of water-level measurements made in wells using graduated steel tapes, electric tapes and air lines. Procedures and accuracy requirements for measuring water levels in a flowing well are also included, as are procedures required to establish a permanent measuring point. This International Standard discusses the advantages and limitations of each method and requirements for recording the data. This International Standard does not include methods that use automated electrical or mechanical means to measure and record water levels.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply:

2.1
air line
water-level measuring device consisting of a small diameter open-ended tube fixed in position that is accessible from the top of the casing and extends to below the water level in a well where pressurized air measurements can be used to determine the depth to water

2.2
casing (well casing)
tubular retaining structure, which is installed in a drilled borehole or excavated well, to maintain the borehole opening. Plain (unscreened) casing prevents the entry of water and fine material into the well, while open (screened) casing allows water ingress but should exclude fines

2.3
electric tape
water-level measuring device that uses an electrical signal, sent through a cable with fixed distance marks, to determine the water level relative to a fixed reference point. The electrical signal, which is induced when the sensor makes contact with the water surface, activates an indicator (typically a light, buzzer or needle)

2.4
flowing well (or overflowing well)
well from which groundwater is discharged at the ground surface without the aid of pumping

NOTE A deprecated term for this definition is an artesian well.

2.5
graduated steel tape
water-level measuring device consisting of a flat measuring tape with permanently fixed distance marks that can be wound on a reel

2.6
groundwater
water within the saturated zone

2.7
land surface datum
average altitude of land surface at a referenced well

2.8
measuring point
permanent reference marked on well casing

2.9
static water level (or static head)
height, relative to an arbitrary reference level, of a column of water that can be supported by the static pressure at a given point

2.10
well
hole sunk into the ground for abstraction of water or for observation purposes

3 Water-level measurement using a graduated steel tape

3.1 Purpose

The purpose of this method is to measure the depth to the water surface (level) below a measuring point using the graduated steel tape (wetted-tape) method.

3.2 Materials and instruments

The following materials and instruments are required.

3.2.1 Steel tape graduated in metres and centimetres.

A black tape is preferred to a chromium-plated tape because the wetted chalk mark is easier to read against a black tape. A break-away weight should be attached to the ring on the end of the tape with wire strong enough to hold the weight, but not as strong as the tape, so that if the weight becomes lodged in the well, the tape can still be pulled free. The weight should be made of brass, stainless steel or iron.

3.2.2 Coloured chalk.

3.2.3 Clean cloth.

3.2.4 Pencil and **eraser.**

3.2.5 Steel tape calibration and **maintenance equipment log book**.

3.2.6 Water-level measurement field form (see the example in Figure 6).

3.2.7 Equipment to gain access to the well (wrenches, crow bars, manhole keys, etc.).

3.2.8 Common household chlorine bleach or other suitable disinfectant.

3.3 Data accuracy and limitations

The following data accuracy and limitations apply.

a) Independent graduated steel tape measurements of static water levels should agree within ± 1,0 cm for depths of less than 60 m;

b) For depths between 60 m and 150 m, independent measurements using the same tape should agree within ± 2,0 cm. When measuring deep water levels (i.e. greater than 300 m), errors due to the effects of thermal expansion and of stretch produced by the suspended weight of the tape and plumbing weight warrant consideration (see Reference [2], p. 3). An example of correcting a deep water level for thermal expansion and stretch of a steel tape is given in Annex A. However, because the equipment required to measure temperatures at land surface and down the well may not always be readily available, the corrections described in Annex A are not required for the purposes of this International Standard, though the practitioner shall note on the water-level field form (see the example in Figure 6) whether or not any such corrections were applied.

c) At least once every twelve months, the steel tape should be calibrated against another steel tape that is dedicated as a calibration tape and is not used in the field. If the steel tape does not meet test criteria, then it must be removed from service. Records of these tests shall be kept.

d) If the well casing is angled, instead of vertical, the depth to water will have to be corrected. If the casing angle is unknown and a correction is not feasible, this should be noted in water-level measurement field form (see the example in Figure 6).

3.4 Advantages and disadvantages

The graduated steel tape method is easy to use and is considered to be the most accurate method for measuring the water level in nonflowing wells of moderate depth. However, it may be impossible to get reliable results if water is dripping into the well or condensing on the well casing. Also, the method is not recommended for measuring pumping levels in wells.

3.5 Assumptions

The following assumptions apply in the use of the graduated steel tape method.

a) An established measuring point (MP) exists and the distance from the MP to land-surface datum (LSD) is known (see the example in Figure 6). See the technical procedure described in Clause 7 for establishing a permanent MP.

b) The MP is clearly marked and described so that all measurements will be taken from the same point.

c) The results from previous water-level measurements made at the well are available for estimating the length of the required tape.

d) The steel tape will retain the chalk.

e) The well is free of obstructions. Well obstructions, if present, could cause errors in the measurement if the obstructions affect the plumbness of the steel tape.

3.6 Procedures

The following procedures for measuring water levels in a well with a graduated steel tape shall be observed.

a) Apply the coloured chalk to the lower metre of the tape by pulling the tape across the chalk. The wetted chalk mark will identify that part of the tape that was submerged.

b) Lower the weight and tape into the well until the lower end of the tape is submerged below the water (more than one attempted measurement may be needed to determine the length of tape required to submerge the weight). Once the end of the tape is submerged, continue to lower the tape into the well until the next whole metre graduation mark is opposite the MP. This whole number shall be recorded in the “MP HOLD” (Figure 1) column of the water-level measurements field form (see the example in Figure 6).

c) Pull the tape back to the surface before the wetted chalk mark dries and becomes difficult to read. Record the number of the wetted chalk mark (sometimes referred to as the cut) in the “WETTED CHALK MARK” (Figure 1) column of the water-level measurements field form (see the example in Figure 6).

d) Subtract the wetted chalk mark number from the number held to the MP, and record this number in the “DEPTH TO WATER FROM MP” (Figure 1) column of the water-level measurements field form (see the example in Figure 6). The difference between these two readings is the depth to water below the MP.

e) Apply the MP correction to get the depth to water below or above land-surface datum (LSD). If the MP is above land surface (see the example in Figure 6), the distance between the MP and land surface datum is subtracted from the depth to water from the MP (see the example in Figure 6) to obtain the depth to water below land surface. If the MP is below land surface, precede the MP correction value with a minus (–) sign and subtract the distance between the MP and land surface datum from the depth to water from the MP to obtain the depth to water below land surface. Record this number in the “DEPTH TO WATER FROM LSD” (Figure 1) column of the water-level measurements field form (see the example in Figure 6). If the water level is above LSD, record the depth to water above land surface as a negative number.

f) Make a check measurement by repeating steps a) through e). The check measurement shall be made using a different MP hold value (see the example in Figure 6) than that used for the original measurement. If the check measurement does not agree with the original measurement to the nearest centimetre, continue to make check measurements until the reason for the lack of agreement is determined or until the results are shown to be reliable. If more than two readings are taken, the observer shall select the reading considered the most reliable. This reading shall be recorded to the nearest centimetre.

g) After completing the well measurements, disinfect the steel tape and weight by pouring a small amount of common household chlorine bleach or other suitable disinfectant on a clean cloth and wiping down the part of the tape that was submerged below the water surface. This will avoid possible contamination of other wells.

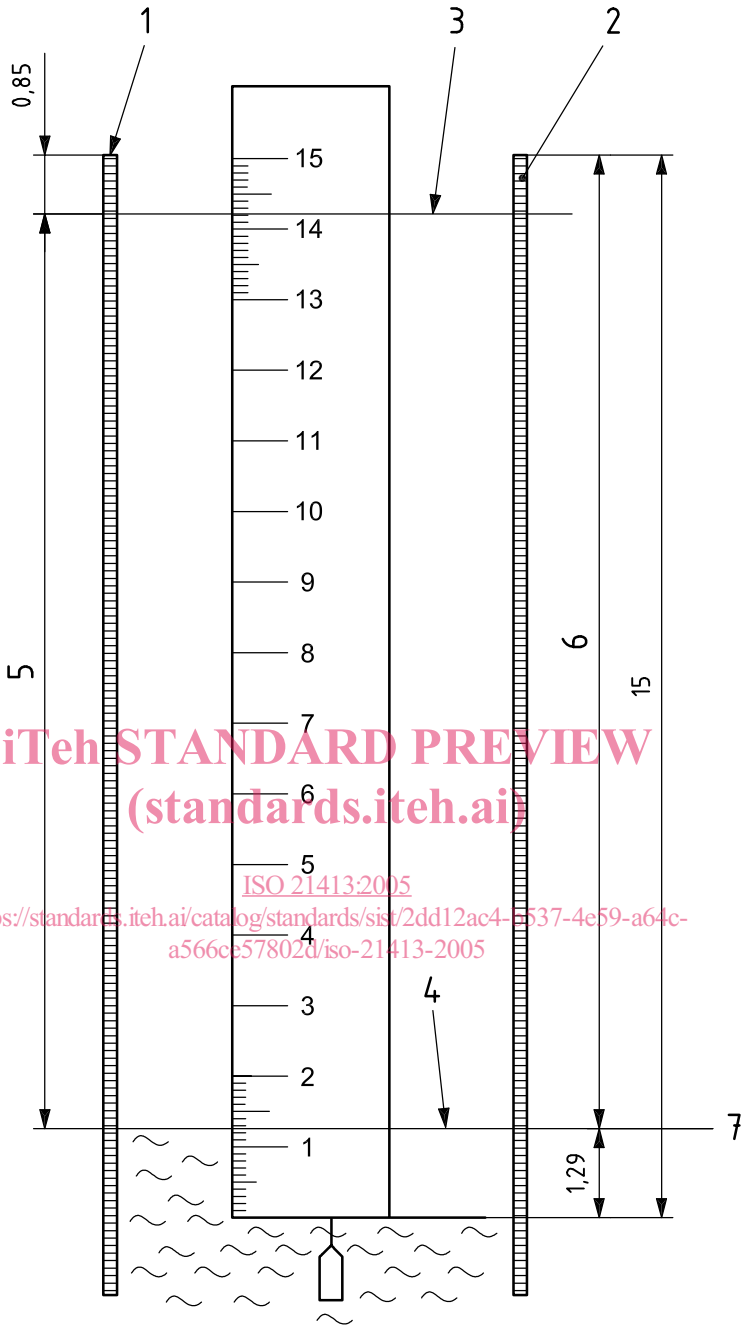
h) The tape shall be maintained in good working condition by periodically checking the tape for rust, breaks, kinks and possible stretch due to the suspended weight of the tape and the tape weight.

All calibration and maintenance data associated with the steel tape being used shall be recorded in its calibration and maintenance equipment log book. All water-level data shall be recorded on the water-level measurements field form (see the example in Figure 6) to the nearest centimetre.

In some contaminated or pumped wells, a layer of oil may be floating on the surface of the water. In such cases, if the thickness of the oil layer is several centimetres or less, the tape reading made at the top of the oil mark can be used as the water-level measurement. The associated error in this case should be relatively small because the level of the oil surface would differ only slightly from the level of the water surface that would be measured if no oil were present. If a meter of more of oil is present, however, or if it is deemed necessary to ascertain the thickness of the oil layer, a commercially-available water-detection paste, originally developed to detect water in gasoline storage tanks, is available to do so. The paste can be applied to the end of the measuring tape that is lowered into the well. The top of the oil layer will be reflected as a wet line on the tape, while the top of the water will be shown by a distinct colour change. In either event, whether the oil layer is greater than or less than a few millimetres in thickness, its presence should be noted on the water-level measurements field form (see the example in Figure 6). A specialized interface probe is also commercially available for measuring the interface.

In the event no water is encountered in the well, this shall be duly noted under “REMARKS” on the field form, along with the distance between the MP and the bottom of the well.

Dimensions in metres



Key

1 measuring point (MP)
2 MP hold
3 land surface datum (LSD)
4 water level
5 depth to water from LSD = 12,86
6 depth to water from MP = 13,71
7 wetted chalk mark

Figure 1 — Water-level measurements using a graduated steel tape

4 Water-level measurement using an electric tape

4.1 Purpose

The purpose of this method is to measure the depth to the water surface below a measuring point using the electric tape method.

Electric tapes fall into two categories:

— Type 1 those that have fixed graduations lacking a suitable frequency (e.g. 1 m graduation) that would enable readings to be made at a sufficient accuracy without the use of additional graduated measures (e.g. tapes calibrated in centimetres). Type 1 tapes are referred to as “partially graduated” tapes in the rest of this clause; and

— Type 2 those with fixed graduations which are spaced at lengths equal to or smaller than the accuracy required for the readings. Type 2 tapes are referred to as “fully graduated” tapes in the rest of this clause.

4.2 Materials and instruments

The following materials and instruments are required.

4.2.1 Electric tape of various wiring arrangements or configurations, that would include flat parallel or co-axial conductive wires, graduated in metres and/or centimetres. Electric tapes are commonly mounted on a hand-cranked supply reel that contains space for the batteries and some device for signalling when the circuit is closed (Figure 2).

4.2.2 Electric tape calibration and maintenance equipment log book.

4.2.3 Pencil and **eraser.**

4.2.4 Water-level measurement field form (Tables 2 and 3).

4.2.5 Equipment to gain access to the well (wrenches, crow bars, manhole keys, etc.).

4.2.6 Common household chlorine bleach, and, for measurements made with Type 1, **electric tapes.**

4.2.7 Steel tape graduated in metres and centimetres.

4.2.8 Spare batteries.

4.3 Data accuracy and limitations

The following data accuracy and limitations apply.

a) Independent electric tape measurements of static water levels using the same tape should agree within ± 1,0 cm for depths of less than 60 m.

b) For depths of about 150 m, the maximum difference of independent measurements using the same tape should agree within ± 3,0 cm.

c) For depths in the 500 m range, the repeatability of measurements using the same tape should agree within ± 15 cm (see Reference [2], p. 11).