INTERNATIONAL STANDARD

ISO 8322-2

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Building construction — Measuring instruments — Procedures for determining accuracy in use —

Part 2: Measuring tapes

Construction immobilière — Instruments de mesure — Procédures de détermination de l'exactitude d'utilisation —

Partie 2: Rubans de mesure

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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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 8322-2 was prepared by Technical Committee ISO/TC 59, *Building construction.*

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

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Building construction — Measuring instruments — Procedures for determining accuracy in use —

Part 2: Measuring tapes

0 Introduction

This International Standard consists of a series of parts specifying test procedures to be adopted when determining and assessing the accuracy in use of measuring instruments in building construction. The first part gives the theory; subsequent parts give the procedures for determining the accuracy in use of measuring instruments for measurements. The complete series will consist of the following parts:

- Part 1: Theory.
- Part 2: Measuring tapes.
- Part 3: Optical levelling instruments.
- Part 4: Theodolites.
- Part 5: Optical plumbing instruments.
- Part 6: Laser instruments.
- Part 7: Instruments when used for setting out.
- Part 8: Electronic distance-measuring instruments.

Other International Standards for testing measuring instruments for land surveying purposes, and for measuring procedures in ordnance survey, are in preparation.

1 Scope

This part of ISO 8322 specifies test procedures to be adopted when determining and assessing the accuracy in use of tapes for measuring length.

2 Field of application

The procedures given in this part of ISO 8322 apply when these measuring tapes are used in building construction for surveying, check and compliance measurements, and also when obtaining accuracy data.

3 References

ISO 3534, *Statistics — Vocabulary and symbols.*

ISO 4463-1, *Measurement methods for building — Setting-out and measurement — Part 1: Planning and organization, measuring procedures, acceptance criteria.*

ISO 7077, *Measuring methods for building — General principles and procedures for the verification of dimensional compliance.*

ISO 7078, *Building construction — Procedures for setting out, measurement and surveying — Vocabulary and guidance notes.*

ISO 8322-1, *Building construction — Measuring instruments — Procedures for determining accuracy in use — Part 1: Theory.*

4 General

4.1 Before commencing surveying, check and compliance measurements, when obtaining accuracy data or setting out, it is important that the operator investigates that the accuracy in use of the measuring equipment is appropriate to the intended measuring task. This International Standard recommends that the operator carries out test measurements under field conditions to establish the accuracy achieved when he uses a particular measuring instrument and its ancillary equipment.

To ensure that the assessment takes account of various environmental influences, two series of measurements need to be carried out under different conditions. The particular conditions to be taken into account may vary depending on where the tasks are to be undertaken. These conditions will include variations in air temperature, wind speed, cloud cover and visibility. Note should also be made of the actual weather conditions at the time of measurement and the type of surface over which the measurements are made. The sets of conditions chosen for the tests should match those expected when the intended measuring task is actually carried out. See ISO 7077 and ISO 7078.

The procedures are designed so that the systematic errors are largely eliminated and assume that the particular tape is in known and acceptable state of user adjustment according to methods detailed in the manufacturer's handbooks.

Accuracy in use procedures require repeat tests to be made with the same instrumentation and the same observer, within a short interval of time. These are "repeatability conditions" as defined in ISO 3534.

The accuracy in use is expressed in terms of the standard deviation.

4.2 Figure 1 indicates schematically the decisions to be made when establishing that the accuracy associated with a given surveying method and particular measuring equipment is appropriate to the intended measuring task. In particular, the decisions apply when adopted by a particular operator under a range of environmental conditions which are likely to occur when the task is actually carried out. Where the contract documentation specifies the required tolerance for the intended measuring task, it is recommended that this tolerance, which is normally given in terms of the permitted deviation $\pm P$ ($P = 2{,}5\,\sigma$) of the measuring task, is compared with the accuracy in use data obtained either from previous accuracy in use tests or from general data A which indicate the expected accuracy in use of given measuring equipment. On those occasions that the previously obtained data indicates that the accuracy in use associated with the given measuring equipment exceeds the specified permitted deviation of the measuring task, consideration should be given to either selecting a different method and/or a more precise instrument, or discussing with the designer the need for such a small permitted deviation. See ISO 4463-1.

Before obtaining an overall estimate of the accuracy in use, it is recommended that each standard deviation for a given series of measurements undertaken under particular environmental conditions is compared, as indicated in figure 1, with the specified permitted deviation. Where the comparison shows that the specified permitted deviation has not been achieved for one series of measurements, an additional series of measurements should be carried out under as near as possible similar environmental conditions to those which applied in that original series of measurements.

Assumptions: $\pm P$ is the permitted deviation of the measuring task

A is the accuracy in use, generally expressed as deviation $\pm A$; (both $\pm P$ and $\pm A$ are considered to include the dimensional variability associated with $\pm$ 2,5 times the standard deviation σ)

s are the deviations obtained in the field tests

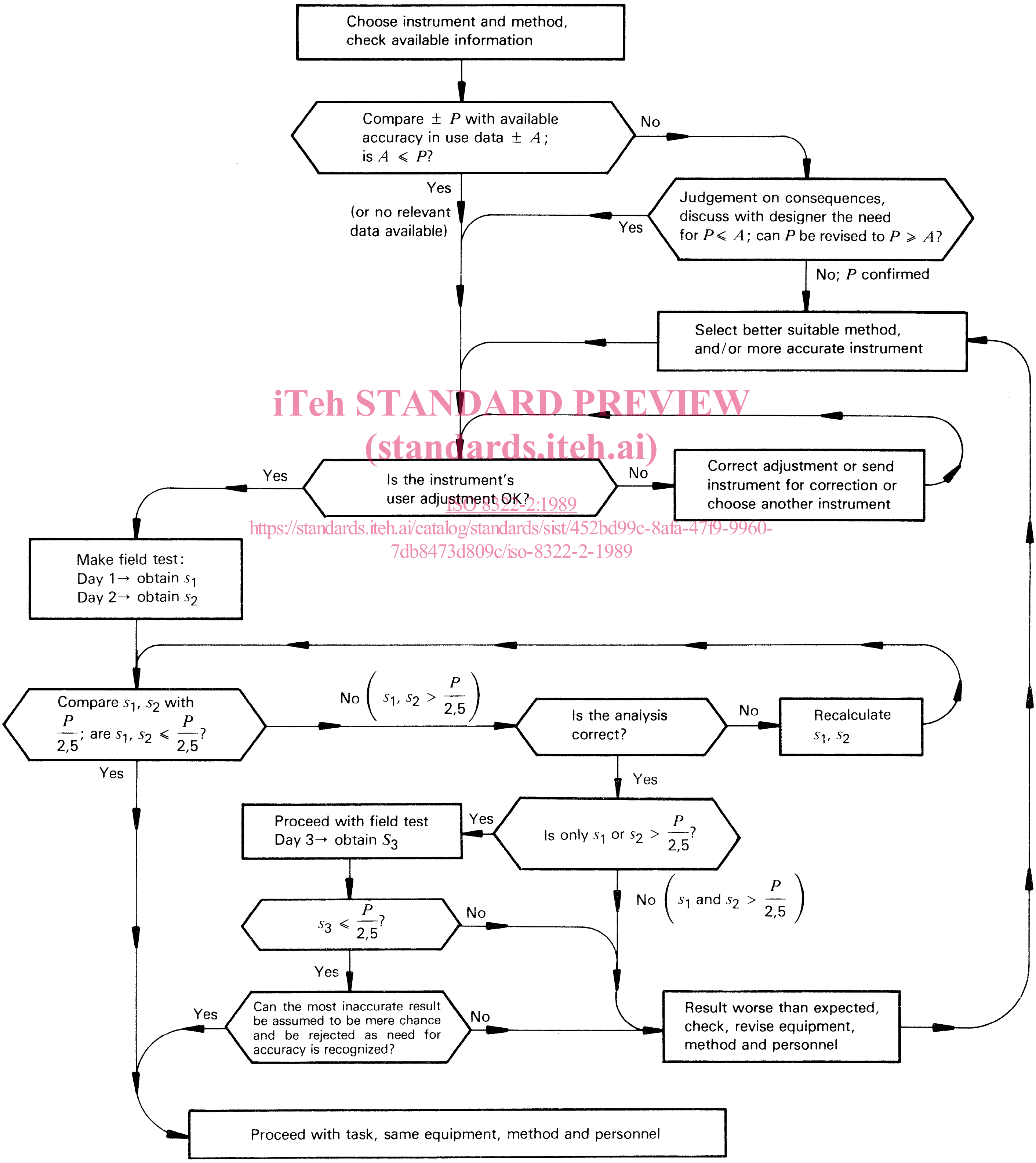

Figure 1 — Flow diagram for accuracy in use tests

5 Procedures for measuring tapes

5.1 The following test procedures should be adopted for determining the accuracy in use by a particular survey team with a particular tape and its ancillary equipment. For setting out, compliance measurement and collecting accuracy data, only tapes recommended in ISO 4463 should be used.

5.2 Observation procedure (see the table)

5.2.1 Establish four points in a straight line so that the distance from the first point to the last point is at least greater than a full length of the tape or commensurate with that expected on a particular construction site (see figure 2).

Make distances A-B, B-C and C-D as dissimilar as possible.

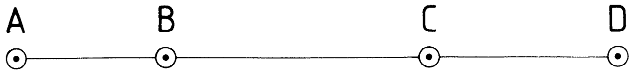

Figure 2 — Measuring distances

The points shall be in stable locations for the duration of the test measurements.

5.2.2 The measuring procedure shall be the same as on site. If the readings of the tape are to be corrected for the influence of tension, sag and temperature on site, the same correction procedures have to be made during the standard procedure for the determination of the accuracy in use of the tape.

5.2.3 Each of the two series of measurements, which should be carried out on separate days, shall consist of five separate readings of the distances A-B, A-C, A-D, B-C, B-D and C-D running on (see column 1 in the table). The five separate readings of each distance should not be measured consecutively.

5.2.4 Record the environmental conditions. Changes of environmental conditions may render the test result inapplicable. In such a case the test should be repeated under the new conditions.

5.3 Calculation procedure

The calculation neglects the relationship between the sum of different lengths and the separate values.

Carry out the following calculation separately for each length of each series of measurements.

5.3.1 Calculate the arithmetic mean $\bar{x}$ (column 4) of the values in column 3.

For example: distance A-B: 9,635 8

5.3.2 Calculate the deviation of each value from the arithmetic mean (column 5).

For example: distance A-B, number 3: + 0,2

To minimize the effect of rounding errors, the calculation of each deviation v should be carried out to the nearest 0,1 mm.

As an arithmetic check the sum of the five deviations should be zero.

5.3.3 Calculate the squares of all values in column 5 and the sum of the squares.

For example: For distance A-B the sum of the squares = 0,80

5.3.4 Calculate the overall sum of the squares.

For example: The sum of the first day is:

$$0{,}80 + 0{,}80 + 26{,}80 + 2{,}80 + 5{,}20 + 1{,}20 = 37{,}60$$

5.3.5 Calculate the standard deviation s of a length measured with the tape on the first day as the square root of the sum of squares divided by 24 = 6 × 4 (6 = number of sets; 4 = redundant observations).

For example: $s_1 = \sqrt{\dfrac{37{,}6}{24}} = \sqrt{1{,}57} = 1{,}2$ mm

5.3.6 Repeat procedures 5.3.1 to 5.3.5 on the second day to obtain s_2.

5.3.7 The overall standard deviation to be expected of any single measurement of a length is

$$s = \sqrt{\frac{s_1^2 + s_2^2}{2}}$$

For example: If s_2 = 1,8 mm then s = 2 mm.

Table 1a) — Field observations and calculation: Example

Date: . . . .

Location: . . . .

Observer: . . . .

Instrument: 30 m white clad steel tape, 5 kgf tension

Conditions: Bright, sunny, cool, fresh wind

Series: I

No.	Line	Length m	Mean $\bar{x}$ m	v mm	v^2 mm²	Line	Length m	Mean $\bar{x}$ m	v mm	v^2 mm²	Line	Length m	Mean $\bar{x}$ m	v mm	v^2 mm²
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	A-B	9,636		+0,2	0,04	A-C	20,568		−0,2	0,04	A-D	39,095		+0,8	0,64
2		9,636		+0,2	0,04		20,569		+0,8	0,64		39,092		−2,2	4,84
3		9,636		+0,2	0,04		20,568		−0,2	0,04		39,091		−3,2	10,24
4		9,635		−0,8	0,64		20,568		−0,2	0,04		39,096		+1,8	3,24
5		9,636		+0,2	0,04		20,568		−0,2	0,04		39,097		+2,8	7,84
			9,635 8	0	0,80			20,568 2	0	0,80			39,094 2	0	26,80

17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
1	B-C	10,930		+0,2	0,04	B-D	29,458		+0,6	0,36	C-D	18,528		+0,4	0,16
2		10,931		+1,2	1,44		29,459		+1,6	2,56		18,527		−0,6	0,36
3		10,930		+0,2	0,04		29,457		−0,4	0,16		18,527		−0,6	0,36
4		10,929		−0,8	0,64		29,457		−0,4	0,16		18,528		+0,4	0,16
5		10,929		−0,8	0,64		29,456		−1,4	1,96		18,528		+0,4	0,16
			10,929 8	0	2,80			29,457 4	0	5,20			18,527 6	0	1,20

$$s_1^2 = \frac{0{,}80 + 0{,}80 + 26{,}80 + 2{,}80 + 5{,}20 + 1{,}20}{6 \times 4} = \frac{37{,}6}{24} = 1{,}57$$

$s_1 = 1{,}2$ mm

$s_2 = 1{,}8$ mm

$$s = \sqrt{\frac{1{,}2^2 + 1{,}8^2}{2}} = 1{,}5 \text{ mm}$$

$s = 2$ mm

Table 1b) — Field observations and calculation: data sheet

Date: ....
Location: ....
Observer: ....
Instrument:
Conditions:
Series:

No.	Line	Length m	Mean $\bar{x}$ m	v mm	v^2 mm²	Line	Length m	Mean $\bar{x}$ m	v mm	v^2 mm²	Line	Length m	Mean $\bar{x}$ m	v mm	v^2 mm²
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 2 3 4 5	A-B					A-C					A-D				
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
1 2 3 4 5	B-C					B-D					C-D				

$s_1^2 = ________ = \quad = $

$s_1 =$

$s_2 =$

$$s = \sqrt{\frac{\quad + \quad}{2}} = \quad \text{mm}$$

$s = \quad$ mm

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