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Optics and optical instruments — Ancillary devices for geodetic instruments —

Part 1: Invar levelling staffs

Optique et instruments d'optique — Equipements annexes pour les instruments géodésiques —

Partie 1: Mires de nivellement en invar

Reference number
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Foreword

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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).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 172, *Optics and photonics*, Subcommittee SC 6, *Geodetic and surveying instruments*.

This second edition cancels and replaces the first edition (ISO 12858-1:1999), which has been technically revised.

ISO 12858 consists of the following parts, under the general title *Optics and optical instruments — Ancillary devices for geodetic instruments*:

— *Part 1: Invar levelling staffs*

— *Part 2: Tripods*

— *Part 3: Tribrachs*

Annex A of this part of ISO 12858 is for information only.

Introduction

The ISO 12858 series consists of several parts which detail specifications for ancillary devices to be used with geodetic instruments in surveying. This part of ISO 12858 specifies requirements for Invar levelling staffs.

Additional parts, covering other ancillary devices, may be added to ISO 12858 as the need arises.

Optics and optical instruments — Ancillary devices for geodetic instruments —

Part 1: Invar levelling staffs

1 Scope

This part of ISO 12858 specifies the most important requirements of Invar levelling staffs used in geodesy and industry for precise measurement of heights in combination with either an optical-mechanical level equipped with a parallel plate micrometre, or a digital level of comparable precision.

It is applicable to

— classical staffs with graduation lines and numbering;

— staffs used in digital levelling with code patterns.

NOTE The measurement uncertainty of the height differences depends on a multitude of influencing factors of the whole measuring system including the levelling instruments.

This part of ISO 12858 is not applicable to the detailed design and construction of Invar levelling staffs (e.g. materials, handles, fixing points for the struts, fixing of the Invar strip and of the circular level), which may be selected by the manufacturer as appropriate.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 9849, *Optics and optical instruments — Geodetic and surveying instruments — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 9849 apply.

4 Design

Invar levelling staffs are normally manufactured in nominal lengths of 2 m or 3 m. However, other alternative lengths may be adopted.

The detailed design and construction are left to the manufacturer.

Examples of Invar levelling staffs are shown in Annex A.

5 Invar scale strip

The Invar strip carrying the scale is classified in Table 1.

Table 1 — Classification of Invar strip

Classification of Invar strip	A	B	C
Coefficient of thermal expansion α	$\lvert\alpha\rvert \leq 0{,}5 \times 10^{-6}\ K^{-1}$	$\lvert\alpha\rvert \leq 1{,}0 \times 10^{-6}\ K^{-1}$	$\lvert\alpha\rvert \leq 1{,}5 \times 10^{-6}\ K^{-1}$
K is the SI unit of temperature in Kelvin			

This classification may be used to specify the quality of the Invar strip.

6 Scale and scale numbering

6.1 Classical staff

The Invar scale strip on levelling staffs may be equipped with one or two parallel sets of scales. The scale marks shall be sharp, parallel and of equal thickness. The colours of the scale marks and of the scale numbering shall be of good contrast. In case of two parallel sets of scales, they shall be offset (staff constant, equal to the difference between the two opposite scale values), the value of which shall be indicated on the staff frame or on the Invar scale strip.

The scale numbering shall be on the staff frame, adjacent to the lnvar scale strip. In the case of two parallel sets of scales, the scale numbering shall be placed adjacent to the respective scales, on each side of the lnvar scale strip.

The maximum deviation (MPE) of the distance between any two scale marks shall not exceed the value specified in Table 2:

Table 2 — Classification of scale

Class	A	B	C
admissible deviation	$\lvert\Delta l\rvert \leq 0{,}015 + l\left(1 \times 10^{-5}\right)$	$\lvert\Delta l\rvert \leq 0{,}025 + l\left(2{,}5 \times 10^{-5}\right)$	$\lvert\Delta l\rvert \leq 0{,}05 + l\left(5 \times 10^{-5}\right)$
where Δl is the admissible deviation (MPE), in millimetres, at 20 °C; l is the distance, in millimetres, between any two scale marks or any two code pattern edges, which are > 200 mm apart.			

6.2 Staffs for digital levels

The scale of staffs for digital levels is different from classical staffs; it consists of a sequence of code patterns.

The admissible deviation for the scale of code staffs shall be compatible with Table 2.

$$\Delta l = l_M - l_S \tag{1}$$

where

l_M is the measured value under a test;

l_S is the standard value by designing of manufacturers.

The test should be accomplished by a special measuring machine.

7 Zero-point error

The measurement to determine this difference shall be made parallel to the staff length axis and perpendicular to the baseplate, at 20 °C. The zero-point error shall not exceed 0,05 mm. Provision for adjusting the zero-point shall be made.

8 Baseplate

The baseplate shall have on its lower side a hardened stainless steel plate. The flatness deviation of the plate shall not exceed 0,02 mm. The baseplate shall be perpendicular, within ± 5', to the staff length axis.

9 Accessories

At a suitable position on the staff frame, two foldable handles and fittings for struts shall be provided. Heat insulating materials should be selected for the handle or handle's jacket.

The alternative use of a centring ring at the baseplate should be possible.

10 Circular level

A circular level having an (usable) indicating range of 15' ± 5' shall be fixed to the backside of the levelling staff.

11 Designation and marking

The marking shall indicate at least the following data on the backside of the levelling staff:

— the name or trademark of the manufacturer (or responsible supplier);

— the individual identification number (serial number).

The staff may be marked additionally on the back with the designation as shown below for the example of a precision levelling staff of 2 m length:

Table 3 — Example designation of Invar levelling staff

1	2		3	4	5
Invar levelling staff	ISO 12858-1	—	2	B	B
1: description 2: International Standard number 3: nominal length (m) 4: classification of Invar strip 5: classification of scale (Δl)					