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	Sample Work Instructions Calibration of Steel Rulers	Effective Date 2002	Revision 00

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Source

Verification regulation of steel ruler

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Prepared by	Approved
23 rd ITTC Quality Systems Group	23 rd ITTC 2002
Date	Date

Calibration of Steel Rulers

PURPOSE

This working instruction can be applied to the verification of a new steel ruler or for the calibration of a ruler in production or in service.

WORK INSTRUCTION

1 Introduction

A steel ruler is a measuring tool made of stainless steel sheet. The lines are engraved on the ruler, on the upper and lower sides. There are six different nominal lengths of the common steel ruler: 150, 300, 500 (600), 1000, 1500, and 2000 mm. The square end of the ruler is the working edge. The other end is semi-circular, with a suspension hole at its centre. The schematic diagrams of their shapes are shown in Figs. 1(a) and 1(b) respectively.

2 Items and Condition of Calibration

2.1 The calibration items and the main tools for the calibration are listed in Table 1.

2.2 The temperature of the room must be in the range of $(20 \pm 5)^\circ\text{C}$ when the indication error of the ruler is calibrated. The calibrated ruler and the calibration tools must be kept in the room for temperature equilibrium no less than 2 h before calibration.

3 Technical Requirements and Calibration Method

3.1 Exterior

3.1.1 Requirements

3.1.1.1 The end edge, the side edge and the back of the ruler must be smooth, without burrs or traces of filings.

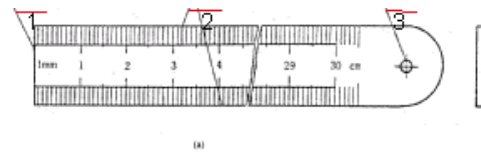


Figure 1 Schematic diagrams of common steel ruler.

Where: 1.end edge; 2.side edge; 3.suspension hole; 4.knife edge plain

3.1.1.2 The ruler should not have mechanical damage, rust and clear spots or scoring on the engraved surface that affects its usage.

3.1.1.1.1 The lines must be clear and perpendicular to the side, without any breaks being visible. The lines of half mm, mm, half cm and cm must be marked with different lengths. The lengths of all the lines with the same interval must be the same. The scale division of the steel ruler should begin from the end edge and the number of centimeter units should be marked on it. The symbol “cm” should be marked at the position of the nominal whole length.


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Table 1

No	Item	Main calibration tools	Sort of calibration	
			New pro-duction	In ser-vice
1	Exterior	Sample block for comparison of surface roughness	+	+
2	Flatness of ruler face	Leveling ruler & plug gauge, both first class	+	+
3	Elasticity	Half circle disk with radius 250mm	+	-
4	Linearity of end & side	Leveling ruler & plug gauge, both first class	+	+
5	Verticality of end and side	First class square & plug gauge, second class leveling ruler	+	+
6	Thickness of side edge	Leveling ruler & plug gauge, both first class	+	-
7	Arc radius at intersection	Tool microscope	+	+
8	Width & its difference of lines	Reading microscope with scale division value 0.01mm	+	-
9	Error of indication	Third grade standard metal line ruler, reading microscope	+	+
Note: “+” means calibration must be done; “-“ means calibration may not be done				

1.1.1.2 The name of the manufacturer (or the brand), scale division value and order number should be noted in the ruler. Numbers, words and lines must be clear, regular without any omission. A newly manufactured ruler must meet the above-mentioned requirements. A ruler in service is allowed to have an exterior fault that does not affect its accuracy.

3.1.2 Method of calibration

The surface roughness can be compared with the sample block by comparison. If there is any suspicion, it can be calibrated by use of a

surface roughness meter. Other exterior items and rulers in service can be checked by eyesight.

3.2 Flatness of ruler face

3.2.1 Requirements

The Flatness of the ruler face should not exceed the limits in Table 2.


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Table 2 (mm)

Length of the calibrated ruler	50	150-500 (600)	1000	1500	2000
Flatness	0.10	0.25	0.40	0.50	0.60

3.2.2 Method of Calibration

The calibrated ruler should be placed onto a first-class leveling ruler, or a leveling plane of the relevant standard, and calibrated over the whole length range, by use of a relevant first-class plug gauge. If the gauge can pass, the calibrated ruler is not up to standard.

3.3 Elasticity

3.3.1 Requirements

First the common steel ruler should be bent into a curve with the radius of 250 mm and then released. The ruler should not have any plastic deformation.

3.3.2 Method of Calibration

The ruler face should be fitted onto the outside circle of a half-ring disk with the radius of 250 mm then be released. After that the ruler can be calibrated based on the requirements and the method of the ruler face flatness described in item 3.2.

3.4 Linearity of the Ruler End and Side Edges

3.4.1 Requirements

The linearity of the ruler end and side edges should not exceed the values in Table 3.

3.4.2 Method of calibration

The end and the side edges of the calibrated ruler should be fitted onto a leveling ruler, or plane, with the relevant standard, then calibrated over the whole length range by use of a relevant first-class plug gauge. If the gauge can pass, the calibrated ruler is not up to standard.

3.5 Verticality of the Ruler End and Side Edges

3.5.1 Requirements

The verticality of the ruler end based on the side edge should not exceed the values shown in Table 3.

Table 3 (mm)

Length of calibrated ruler	linearity		verticality
	End edge	Side edge	
50	0.02	0.04	0.03
150	0.03	0.10	0.04
300	0.04	0.20	0.06
500(600)	0.04	0.25	0.06
1000	0.04	0.40	0.07
1500	0.04	0.50	0.09
2000	0.04	0.60	0.09

3.5.2 Method of Calibration

Both the side edges of the calibrated ruler should be placed onto a second-class leveling ruler of the relevant standard, so that the en-

graved surface is normal to the working surface of the leveling ruler. At the same time the ruler end edge should be kept touching the vertical edge of a first-class square, which is placed on the leveling ruler. The gaps between the upper-side or the lower-side of the calibrated ruler end edge should be calibrated by use of a first-class plug gauge. The values are not allowed to exceed the values shown in Table 3.

3.6 Thickness of the Side Edge

3.6.1 Method of Calibration

The calibrated ruler should be placed horizontally on a first-class leveling ruler, or a first-class plane, with the engraved surface downwards and calibrated by use of the comparison method with a first-class plug gauge of 0.2 and 0.3mm.

3.7 Arc Radius at the Intersecting Position of the End and the Side Edges

3.7.1 Requirements

The arc radius of a newly produced common steel ruler should not exceed 0.2 mm.

3.7.2 Method Calibration

This can be observed visually. If there is any query, it can be calibrated by use of the arc eye lens of a tool microscope.

Table 5 (mm)

Normal length	50,150,300	500(600)	1000	1500	2000
Whole length	±0.10	±0.15	±0.20	±0.27	±0.35
Note: The indication error between the end side and the first line is ±0.08mm					

3.8 Width and Difference Between the Lines.

3.8.1 Requirements

The width and difference between the lines should not exceed the values in Table 4

Table 4 (mm)

Length of the calibrated ruler	Width of the lines	Width difference of the lines
50, 150	0.10~0.20	0.04
300~2000	0.15~0.25	0.05

3.8.2 Method of Calibration

It can be calibrated by use of a reading microscope with a scale division value of 0.01mm.

3.9 Error of Indication

3.9.1 Requirements

- The indication error of the whole length and from any line to the end edge or the line at the end edge should not exceed the values given in Tables 5 and 6.
- The indication error between any lines of the steel ruler which is applied to deliver the value as standard should not exceed the values in Table 6.

Table 6 (mm)

Size range	Indication error from any line to end edge or to end edge line
> 1~300	±0.10
> 300~600	±0.15
> 600~1000	±0.20
> 1000~1500	±0.27
> 1500~2000	±0.35

3.9.2 Method of Calibration

For the calibration of the whole length indication error, third grade standard metal line rulers[Ⓞ] and calibrated rulers with the lengths less than 1000 mm should be put on a main platen 10 or an adjustable platen 11 of a steel ruler calibration table, see Fig. 2. Other work-

ing tables, which meet the calibration requirements, can also be used.

In Fig. 2, the lift nut 4 should be adjusted until the engraved surface of the calibrated ruler and the side edge of the standard ruler are in the same plane. The mutual position between the calibrated ruler and the standard ruler is shown in Fig. 3. The butterfly nut 6 should be screwed for fixing the vertical position of the standard and the calibrated rulers. The calibrated ruler should be adjusted until its line axis is parallel to the side edge of the standard ruler. The zero-position adjusting bolt 8 should be turned until the end edge line of the standard ruler is aligned with the end edge of the calibrated ruler. The error of the calibrated ruler can be read from the standard ruler by use of a magnifier attached to the standard ruler.

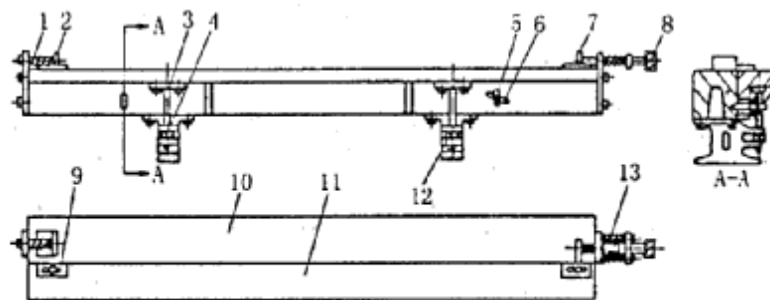


Figure 2 Schematic diagram of the steel ruler calibration table

Where: 1.spring; 2.sustaining block; 3.lift screw; 4.lift-adjusting nut; 5.fastening screw; 6.butterfly nut; 7.sustaining block; 8.zero-position adjusting bolt; 9.calibrated ruler positioning platen; 10.main platen; 11.adjustable platen; 12.Feet; 13.spring

The positioning plate 9 of the calibration table should be taken away, for the calibration of rulers with lengths of 1500 and 2000 mm based on the following method: The ruler with a length of 1500 mm can be calibrated by being divided into two sections, 1000 and 500 mm, the ruler with the length of 2000 mm, into two 1000 mm sections. The error of the whole length will be the algebraic sum of these two sections. The ruler whose length is beyond 1000 mm can be divided into two sections compared with the standard. Its error is the algebraic sum of these two sections.

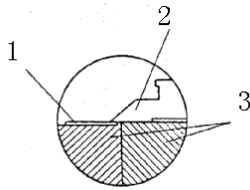


Figure 3 Mutual position

Where: 1. steel ruler; 2. standard ruler;
3. calibration table

The indication error of the first half-millimeter and millimeter can be calibrated by use of the reading microscope with the scale division value of 0.01mm.

The indication error of the lines on the engraved plane at the both sides of the ruler must

be calibrated. Their errors should not be beyond the value given in clauses 3.9.1 and 3.9.2.

Reading the values during the calibration, the central value of every line should be taken. The line interval of the third grade standard metal line ruler should be used on the basis of the actual size.

The indication error of the ruler can also be calibrated on the basis of other methods which meet the requirement of the accuracy.

4 Treatment of the Calibration Result and the Calibration Period

- 4.1 For steel rulers which meet the requirements of this working instruction, a calibration protocol will be supplied or a qualified mark will be glued to the surface of the ruler with the validity period noted; The ones which do not meet the requirement should be put out of use.
- 4.2 The calibration period of the steel ruler in service can be determined on the service condition, usually one-year.

Note: ① The room temperature should be in the range $(20 \pm 2)^{\circ}\text{C}$ for the third grade standard metal line rulers made of invar.