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| | Work Instructions Verification of Steel Rulers | Effective Date 2024 | Revision 00 |

ITTC Quality System Manual

Recommended Procedures and Guidelines

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Verification of Steel Rulers

- 7.6 Control of Inspection, Measuring and Test Equipment
- 7.6-02 Sample Work Instructions
- 7.6-02-01 Verification of a Steel Ruler

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| Updated / Edited by | Approved |
| Quality Systems Group of the 30 th ITTC | 30 th ITTC 2024 |
| Date: 07/2022 | Date: 09/2024 |
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Source

Verification regulation of steel ruler

[Issued on Oct.18, 1999 and put into effect since March 15, 2000 by National Technical Bureau - JIG 1—1999, National Measuring Verification Regulation of People’s Republic of China]

Verification of Steel Rulers

1. PURPOSE

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

2. WORK INSTRUCTION

2.1 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 its shape is shown in Fig. 1.

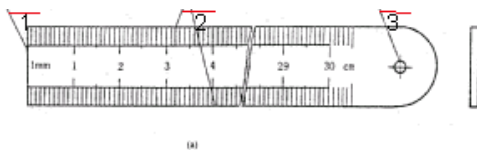


Figure 1 Schematic diagrams of common steel ruler, where: 1. end edge; 2. side edge; 3 suspension hole.

3. ITEMS AND CONDITION OF VERIFICATION

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

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 verified. The verified ruler and the verification tools must be kept in the room for temperature equilibrium no less than 2 h before verification.

4. TECHNICAL REQUIREMENTS AND VERIFICATION METHOD

4.1 Exterior

4.1.1 Requirements

1. The end edge, the side edge and the back of the ruler must be smooth, without burrs or traces of filing.
2. The ruler should not have mechanical damage, rust and clear spots or scoring on the engraved surface that affects its usage.
3. 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 centimetre units should be marked on it. The symbol “cm” should be marked at the position of the nominal whole length.

| No | Item | Main verification tools | Sort of verification | |
|----|------------------------------------|---|----------------------|-----------------|
| | | | New pro- duction | In ser- vice |
| 1 | Exterior | Sample block for com- parison of surface rough- ness | + | + |
| 2 | Flatness of ruler face | Levelling ruler & plug gauge, both first class | + | + |
| 3 | Elasticity | Half circle disk with ra- dius 250mm | + | - |
| 4 | Linearity of end & side | Levelling ruler & plug gauge, both first class | + | + |
| 5 | Verticality of end and side | First class square & plug gauge, second class lev- elling ruler | + | + |
| 6 | Thickness of side edge | Levelling 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 verification must be done; “-” means verification may not be done

Table 2 (mm)

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

4. 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.

4.1.2 Method of verification

The surface roughness can be compared with the sample block by comparison. If there is any suspicion, it can be verified by use of a surface roughness meter. Other exterior items and rulers in service can be checked by eyesight.

4.2 Flatness of ruler face

4.2.1 Requirements

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

4.2.2 Method of verification

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

4.3 Elasticity

4.3.1 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.

4.3.2 Method of verification

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 verified based on the requirements and the method of the ruler face flatness described in item 3.2.

4.4 Linearity of the Ruler End and Side Edges

4.4.1 Requirements

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

4.4.2 Method of verification

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

4.5 Verticality of the Ruler End and Side Edges

4.5.1 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 verified 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 |

4.5.2 Method of verification

Both the side edges of the ruler to be verified should be placed onto a second-class levelling ruler of the relevant standard, so that the engraved surface is normal to the working surface of the levelling 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 levelling ruler. The gaps between the upper-side or the lower-side of the verified ruler end edge should be verified by use of a first-class plug gauge. The values are not allowed to exceed the values shown in Table 3.

4.6 Thickness of the Side Edge

The thickness of the side edge of the cotton fibre steel ruler should be 0.2~0.3 mm.

4.6.1 Method of verification

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

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

4.7.1 Requirements

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

4.7.2 Method verification

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

4.8 Width and Difference Between the Lines.

4.8.1 Requirements

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

Table 4 (mm)

| Length of the verified 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 |

4.8.2 Method of verification

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

4.9 Error of Indication

4.9.1 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 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 | | | | | |

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 |

For the verification of the whole length indication error, third grade standard metal line rulers and verified 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 verification table, see Fig. 2. Other working tables, which meet the verification requirements, can also be used.

4.9.2 Method of verification

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

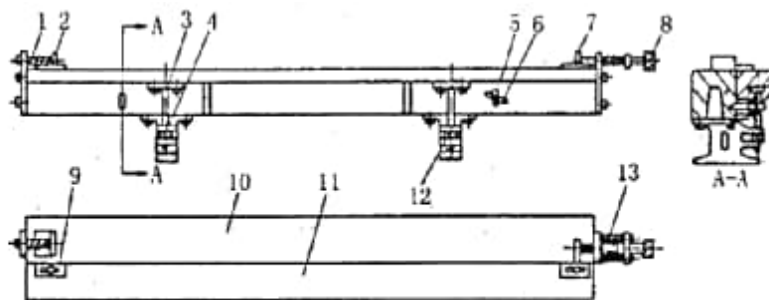


Figure 2 Schematic diagram of the steel ruler verification table

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. verified ruler positioning platen; 10. main platen; 11. adjustable platen; 12. Feet; 13. spring

In Fig. 2, the lift nut 4 should be adjusted until the engraved surface of the verified ruler and the side edge of the standard ruler are in the same plane. The mutual position between the verified 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 verified rulers. The verified 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 verified ruler. The error of the verified ruler can be read from the standard ruler by use of a magnifier attached to the standard ruler.

The positioning plate 9 of the verification table should be taken away, for the verification of rulers with lengths of 1500 and 2000 mm based on the following method: The ruler with a length of 1500 mm can be verified 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.

The indication error of the first half-millimetre and millimetre can be verified 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 both sides of the ruler must be

verified. Their errors should not be beyond the value given in clauses 4.9.1 and 4.9.2.

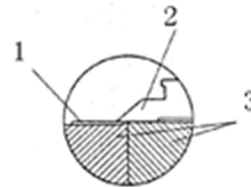


Figure 3 Mutual position, where: 1. steel ruler; 2. standard ruler; 3. verification table

Reading the values during the verification, 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 verified on the basis of other methods which meet the requirement of the accuracy.

5. TREATMENT OF THE VERIFICATION RESULT AND VERIFICATION PERIOD

For steel rulers which meet the requirements of this working instruction, a verification 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.

The verification period of the steel ruler in service can be determined on the service condition, usually one-year.