

INTERNATIONAL
RECOMMENDATION

OIML R 48

Edition 1980 (E)

Tungsten ribbon lamps
for calibration of optical pyrometers

Lampes à ruban de tungstène pour l'étalonnage des pyromètres optiques



Foreword

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TUNGSTEN RIBBON LAMPS for CALIBRATION of OPTICAL PYROMETERS

— SECTION I —

GENERAL

1. Scope.

- 1.1. This Recommendation applies to tungsten ribbon lamps used for the calibration of optical pyrometers.
 - 1.1.1. The Recommendation sets out the requirements the tungsten ribbon lamps must comply with when subjected to State metrological controls.
- 1.2. This Recommendation is intended to ensure that :
 - 1.2.1. the tungsten ribbon lamps are suitable for the calibration of all optical pyrometers, covered by OIML Recommendation No. 18 ;
 - 1.2.2 the calibration of these lamps may be carried out in all countries, in a uniform manner and with the degree of accuracy indicated below.
- 1.3. This Recommendation establishes for these lamps :
 - 1.3.1. the units approved for temperature measurement,
 - 1.3.2. the general technical characteristics,
 - 1.3.3. the main parameters characterizing their metrological properties, and the numerical values of these parameters,
 - 1.3.4. the main methods to be used to ensure uniformity of calibration.

— SECTION II —

UNITS. TECHNICAL CHARACTERISTICS

METROLOGICAL CHARACTERISTICS

2. Units.

- 2.1. Tungsten ribbon lamps must be calibrated in accordance with the 1968 International Practical Scale of Temperature, taking account of any amendments or modifications subsequently applied to this Scale.

Temperature must be expressed in :
degrees Celsius with symbol °C or,
kelvins with symbol K.
- 2.2. Tungsten ribbon lamps reproduce a luminance temperature scale (spectral radiance temperature), for a wavelength of (655 ± 10) nm.

2.3. If necessary, the lamps can be calibrated for light having a different wavelength, provided that the glass of the lamp, or, where appropriate, the window, is sufficiently transparent for this wavelength. In this case, the value of this wavelength must be indicated in the certificate for the lamp.

3. Technical characteristics.

3.1. Tungsten ribbon lamps are classified in two groups :

- lamps of ordinary accuracy, and
- lamps of high accuracy.

3.2. Lamps of ordinary accuracy and lamps of high accuracy are differentiated by the value of at least one of the following parameters :

- the temperature homogeneity of the target area,
- the stability,
- the calibration error.

3.3. Tungsten ribbon lamps are also sub-divided into two types : vacuum lamps and gas-filled lamps.

3.4. The bulb of a tungsten ribbon lamp must be manufactured in colourless transparent glass, with no defects in the field of view.

3.4.1. Tungsten ribbon lamps of high accuracy must have plane windows inclined, with respect to the viewing axis (normal to the ribbon), at an angle designed to eliminate those mutual reflections liable to affect pyrometer readings ; this angle must not exceed 10° .

The useable window aperture (that is, the ratio of the window diameter to the distance between the window and the ribbon), must not be less than $1/4$.

3.5. The tungsten used to manufacture the incandescent ribbon must possess high dimensional stability up to a luminance temperature of about $2\ 300^\circ\text{C}$.

3.6. The total length of the ribbon must be such that the homogeneity of the temperature distribution along it meets the requirements of point 4.3, and the temperature coefficient those of point 4.8.

3.6.1. The following geometrical ribbon dimensions are recommended :

- width : 1.2 to 5.0 mm,
- thickness : 20 to 70 μm ,
- total length : over 40 mm.

3.6.2. Irrespective of the position of the ribbon within the lamp, both ends of the ribbon must be mechanically held in such a way that displacement of the target area is minimised when the temperature is changed.

3.7. The target area of the ribbon (close to the area of highest temperature), must be indicated by a marker.

If the marker takes the form of a notch in the edge of the ribbon, its depth, in the case of a tungsten ribbon lamp of high accuracy, must not exceed 5 % of the width of the ribbon.

- 3.8. The bulb of a tungsten ribbon lamp must incorporate reference elements (or markers), for positioning the lamp ribbon at the correct angle between the viewing axis of the pyrometer and the normal to the ribbon, with a permissible deviation of $\pm 2^\circ$ for lamps of high accuracy and $\pm 5^\circ$ for lamps of ordinary accuracy.
- 3.9. It is recommended that power to the lamp should be supplied through terminals, as opposed to screw sockets.
- 3.9.1. For tungsten ribbon lamps of high accuracy, the socket support and electrical conductors should be thermostatically controlled, their temperature, stated in the certificate for the lamp, being maintained constant to within $\pm 2^\circ\text{C}$.
- 3.9.2. Tungsten ribbon lamps must be supplied with DC power. The direction of the current must be indicated on the lamp terminals, and in the certificate for the lamp.
- 3.10. The ageing (that is annealing intended to ensure good stability of the lamp characteristics), may be carried out using either AC or DC power supply.
- 3.10.1. The stabilization of tungsten ribbon lamps of ordinary accuracy must be carried out for a period of 100 hours at a temperature at least 200°C above the maximum operating temperature. However, this temperature must not exceed 1800°C for vacuum lamps, or 2300°C for gas-filled lamps.
- The variation in the stabilizing temperature must not exceed $\pm 30^\circ\text{C}$.
- 3.10.2. The stabilization of tungsten ribbon lamps of high accuracy must be carried out for a period of 200 hours, at a temperature at least 300°C above the maximum operating temperature. However, this temperature must not exceed 1800°C for vacuum lamps, or 2300°C for gas-filled lamps.
- The variation in the stabilizing temperature must not exceed $\pm 20^\circ\text{C}$.
- 3.10.3. During stabilization, the temperature must be measured by an optical pyrometer, with an effective wavelength of 655 nm.
- 3.11. Each tungsten ribbon lamp must carry the following information : number, type (see 3.3), maximum operating temperature, manufacturer's mark, and year of manufacture.

4. Metrological characteristics.

- 4.1. As indicated in point 3.1, tungsten ribbon lamps are divided into two groups, lamps of ordinary accuracy, and of high accuracy.

The first category must be suitable for the calibration of optical pyrometers of ordinary accuracy, and the second for the calibration of optical pyrometers of high accuracy.

- 4.2. The metrological properties of tungsten ribbon lamps are characterized by the following parameters :

- 4.2.1. the temperature homogeneity of the target area,
- 4.2.2. the stability,
- 4.2.3. the calibration error.

4.3. The temperature homogeneity of the target area is characterized by maximum variation in the temperature observed when the target area is displaced by ± 0.5 mm along or across the ribbon, starting from the normal operating point indicated by the marker. This variation must not exceed the values indicated in column 4 of table I.

Table I

Accuracy	Type of tungsten ribbon lamp	Temperature range °C	Maximum permissible inhomogeneity °C	Maximum permissible instability °C	Maximum permissible calibration error °C
1	2	3	4	5	6
Ordinary accuracy	Vacuum lamps	800-1 000	± 1.5	± 0.5	± 3.0
		1 000-1 700	± 2.5	± 1.0	± 4.0
	Gas-filled lamps	1 300-2 000	± 2.0	± 2.0	± 5.0
		2 000-2 300	± 2.5	± 4.0	± 6.0
High accuracy	Vacuum lamps	800-1 000	± 0.10	± 0.2	± 1.5
		1 000-1 700	± 0.10	± 0.4	± 2.5
	Gas-filled lamps	1 300-2 000	± 0.5	± 1.0	± 4.0
		2 000-2 300	± 1.0	± 2.0	± 4.5

4.4. The lamp instability is characterized by the variation of the temperature characteristic, over a period of 66 hours operation at maximum temperature.

Instability is measured at a temperature of 1 400 °C for all types of lamps. It must not exceed the values indicated in column 5 of table I.

4.5. The calibration error is the difference between the luminance temperature value indicated in the lamp certificate, and the conventional true value of the luminance temperature.

The lamp calibration error must not exceed the maximum permissible errors given in column 6 of Table I.

4.6. The time required by tungsten ribbon lamps to reach thermal equilibrium, after switching on, must not exceed the values indicated in Table II below.

Table II

Type of tungsten ribbon lamp	Temperature range C°	Maximum time to reach thermal equilibrium (minutes)
Vacuum lamps	800-1 000	20
	1 000-1 700	20
Gas-filled lamps	800-1 400	20
	1 400-2 000	25
	2 000-2 300	30

At the end of the time indicated, the further change in the lamp temperature must not exceed 1 °C.

In the event of a change in temperature, and where the alteration is greater than 100 °C, a pause of at least 10 minutes is necessary before the lamp is used again.

4.7. The normal operating conditions for a tungsten ribbon lamp are as follows :

- in the correct working position,
- at the viewing angle indicated in the certificate for the lamp,
- ambient air temperature equal to $(20^{\circ} \pm 5^{\circ}\text{C})$,
- relative humidity of the ambient air equal to $(65 \pm 15 \%)$.

4.8. For vacuum lamps, the temperature coefficient at the freezing point of gold, must not exceed 0.05 for lamps of high accuracy, or 0.2 for lamps of ordinary accuracy.

The temperature coefficient is the ratio between the change in the luminance temperature and that in the temperature of the ambient air when the latter varies.

— SECTION III —

CALIBRATION

5. Calibration of lamps.

5.1. The following requirements should be adopted, so that the maximum permissible errors are maintained.

5.1.1. Lamps of ordinary accuracy are calibrated with special optical pyrometers, photoelectric pyrometers and spectral comparators, with uncertainties not exceeding :

- 2 °C for the range 800-1 000 °C,
- 1 °C for the range 1 000-1 400 °C,
- 2 °C for the range 1 400-2 000 °C,
- 3.5 °C for the range 2 000-2 300 °C.

5.1.2. Lamps of high accuracy are calibrated using photoelectric pyrometers and spectral comparators, with error values not exceeding :

- 1 °C for the range 800-1 000 °C,
- 0.5 °C for the range 1 000-1 400 °C,
- 1 °C for the range 1 400-2 000 °C,
- 2 °C for the range 2 000-2 300 °C.

5.2. Calibration is carried out at an effective wavelength of (655 ± 10) nm, or at an alternative wavelength, the value and estimated accuracy of which are indicated in the certificate.

5.3. Lamps used to reproduce a luminance temperature scale at a wavelength other than 655 nm, must also be calibrated at the wavelength (655 ± 10) nm.

5.4. Checking of stability, temperature homogeneity, etc., must be carried out at a wavelength of (655 ± 10) nm, using photoelectric pyrometers and spectral comparators.

The resolution of these instruments must not exceed :

0.1 °C for verification of the lamps of high accuracy.

0.3 °C for verification of the lamps of ordinary accuracy.

— SECTION IV —

METROLOGICAL CONTROLS AND SANCTION

6. Metrological controls.

In a country where tungsten ribbon lamps are subject to State metrological controls, these controls must include all or some of the following, according to the internal legislation of the country concerned :

6.1. Pattern approval.

6.1.1. Each pattern of lamp from each manufacturer is subject to approval procedure.

6.1.2. If modifications are made to an approved pattern, this pattern must be submitted for a new approval.

6.2. Primary annealing (ageing) must be certified either by a note in the certificate for the lamp or by affixing a mark.

6.3. Calibration of lamps must be carried out in accordance with detailed requirements which comply with this Recommendation.

6.4. All lamps must be verified at least once a year.

6.5. Periodic checks will be made on lamps in service, to ensure that their metrological qualities are maintained.

6.6. To ensure uniformity of measurement of high temperatures, systematic international comparisons of standard lamps must be carried out.

These comparisons should be carried out at 5 year intervals.

7. Sanction of controls.

Verification results are sanctioned by the issue of a certificate.

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