

ISO:9001-2015	Document No.: TM/67	Revision-03	Date Effective From 07.06.2022
Document Title: Specification of Magnetic Base Type Rail Thermometer			



**Specification of Magnetic Base Type Rail Thermometer
(No.: TM/67 dt. 28.01. 2002)**

Third Revision, 2022

Track Machines & Monitoring Directorate

**RESEARCH DESIGNS AND STANDARDS ORGANISATION
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1.0 Scope:

This specification covers the Reference, Terminology, Materials, Processing and Workmanship, Functional Requirements, Technical Features, Graduation and figuring, Tests, Inspection, Warranty & AMC, Service Facility and Spare Parts (including tools), Documentations, Training and Commissioning and Marking and Packing for magnetic base type rail-thermometer which is used for measuring rail temperature. In this specification “magnetic base type rail-thermometer”, will be termed as “thermometer” for convenience.

1.1 Preference to Make in India: Compliance of the instruction contained in Public Procurement (Preference to Make in India) Order -2017 “Make in India” and latest guidelines issued in this regard shall be ensured.

1.1 Supplier is fully responsible to maintain the quality of product supplied to Indian Railways.

2.0 Reference:

Following documents, full sets of the relevant drawings and BIS specification duly incorporating the updated corrections/ amendments should be available for reference at manufacturer’s works.

(i)	IS: 2627-1979 (Reaffirmed 2002)	Glossary of terms relating to liquid-in-glass thermometers.
(ii)	IS: 4610-1968 : (Reaffirmed 2006)	Specification for glass tubes for general purpose and reference thermometers.
(iii)	IS: 6274-1971 (Reaffirmed 2002)	Method of calibrating liquid-in-glass thermometers.
(iv)	IS: 8787-1977 (Reaffirmed 1999)	Principles of design, construction and use of liquid-in-glass thermometers.
(v)	IS:531-1981 (Reaffirmed 2006)	Specification for leaded brass strip for instrument parts.
(vi)	IS: 3331-2007	Specification for copper and brass strips/ foils for radiator cores.
(vii)	IS:733-1983 (Reaffirmed 2006)	Specification for wrought aluminum and aluminum alloy bars, rods and sections for general engineering purposes.
(viii)	BS:1365-1975	Specification for short range short stem Thermometer
(ix)	RDSO Drg. No. TM/0201	Magnetic Base Type Rail thermometer.

3.0 TERMINOLOGY: Following terms and definitions shall apply for the purpose of this specification.

3.1 **Agging:** The process of heat treatment or storage of a thermometer, after which its calibration does not change with time in normal use or when kept in store.

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- 3.2 **Ambient Temperature:** The temperature of surrounding air.
- 3.3 **Blow Bulb Thermometers:** A liquid-in-glass thermometer whose bulb has been formed by blowing out of the glass capillary.
- 3.4 **Bulb:** The glandular portion at one end of the liquid-in-glass thermometer, which contains the main volume of the thermometric liquid.
- 3.5 **Bulb length:** The axial distance between the shoulder and the bottom of the bulb.
- 3.6 **Capillary (of Thermometers):** Transparent glass tubes of round or prismatic cross section, generally provided with a white or yellow opal glass backing with suitably placed oval or round bore; used for stem of thermometers.
- 3.7 **Calibration of Thermometer:** The comparison of a thermometer with standard reference thermometer for determining its accuracy.
- 3.8 **Calibration Error:** The deviation in the indication of a thermometer from the actual temperature observed during calibration.
- 3.9 **Clouding:** Loss of transparency of the capillary of a thermometer due to de-vitrification, deposition of vapours, solids, etc.
- 3.10 **Correction:** A value equal but opposite in sign, to the error at a certain point on the scale of a thermometer. It's algebraic addition to the reading of the thermometer gives the actual temperature.
- 3.11 **Degree Celsius (0⁰C):** The recognized unit for temperature, temperature difference and temperature interval.
- 3.12 **Depth of Immersion:** The length of thermometers that remains immersed in the medium whose temperature is being measured.
- 3.13 **Emergent Column:** The portion of the thermometric liquid column which remains outside the medium at the time of taking its temperature.
- 3.14 **Enameled Back:** The white or coloured opaque surface at the back of the capillary of a thermometer to facilitate location of the thermometric liquid.
- 3.15 **Figuring (of thermometer):** The marking of digits and numerals on the scale(s) of a thermometer.
- 3.16 **Graduation lines:** Lines on the scale(s) of a thermometer indicating temperature.
- 3.17 **Graduation interval:** The distance (in mm) between two consecutive graduation lines.
- 3.18 **Least count:** Or 'Smallest Scale Division' is the temperature interval between two successive graduations of thermometer.
- 3.19 **Liquid-in-Glass Thermometer:** A thermometer in which the thermal expansion of a liquid (thermometric liquid) enclosed in glass bulb and capillary is used to indicate temperature.

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3.20 **Length of Main Scale:** Axial length in mm of thermometer scale from its maximum nominal temperature mark to its minimum nominal temperature mark.

4.0 **MATERIALS, PROCESSING AND WORKMANSHIP:**

4.1 The rail thermometer shall be of liquid (mercury) in-glass, solid stem type. The thermometer shall be enclosed in a metallic tube with provision of suitable magnet at its base.

4.2 **Capillary tube:** The capillary tube shall be made of any of the thermometric glasses as approved by National Physical Laboratory (Ref. Appendix-A of BS: 1365-1975). The capillary shall be prismatic type with white / yellow enamel back.

4.3 **Thermometric liquid:** Thermometric liquid shall be mercury of high purity.

4.4 **Metallic casing:** The metallic casing (rotary cover) and the inner sheath shall be of extruded aluminum tube conforming to IS: 733-1983 (Reaffirmed 2006) (Gr.19500).

4.5 **Magnetic Base:** The base plate shall be made from brass sheet of 0.6 mm thick conforming to any of the three grades as per IS: 531-1981 (Reaffirmed 2006). The gripping clip for enclosing the bulb shall be made from copper strip of thickness 0.4 mm, conforming to any of the three grades as per IS: 3331-2007.

4.6 **Supporting Neck:** The supporting neck and insert moulded rail contact shall be made of glass filled nylon of superior quality and shall be threaded to the casing as mentioned in the drawing.

4.7 **Top Cap:** The top cap shall be made of glass filled nylon of superior quality or of aluminum conforming to IS: 733-1983 (Reaffirmed 2006) (Grade-19500). The cap shall be screwed into the inner sheath and shall have suitable locking arrangement for both open and close position of the casing by spring and stainless steel ball as shown in the drawing.

4.8 **Magnet:** The magnet shall be of permanent high power rare earth type. The material shall be 'Neodymium Ferrous Alloy' with hard zinc plating. The strength of the magnet shall be minimum 1800 gauss.

5.0 **FUNCTIONAL REQUIREMENTS:**

5.1 **Appearance:** Glass capillary shall be of clear transparent glass, free from occlusions, stain, stresses and other visual defects such as bubbles, knots, reflection failures and roughness of bore. A safety chamber shall be provided at the top end, in line with the capillary bore. The safety chamber shall be adequate for a rise of at least 20°C temperature above the specified higher range.

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- 5.2 The thermometer shall have magnetic base. The magnet shall be fitted at the periphery of the circular base plate as shown in the drawing. The base plate shall have good and direct contact with the rail top for rapid conduction of heat from rail to thermometer, when placed on the top of rail.
- 5.3 The bulb of the thermometer shall be encased in a gripping clip which shall be fitted centrally with the base plate by soldering to provide sound metallic contact between the two. The gripping clip shall have a coaxial spring (fitted from outside) for proper contact with the thermometer bulb.
- 5.4 The thermometer shall be enclosed in a metallic tube (inner sheath).The inner sheath shall be enclosed in an outer casing. Both the tubes i.e. inner sheath and the outer casing (rotary cover) shall have an opening lengthwise for viewing the thermometer scale from outside. . The casing shall have a suitable inbuilt lid to open and close the opening when required.
- 5.5 The thermometer shall be designed to firmly stick to the rail top by magnetic action of the base of the thermometer when placed on the top of rail head and shall stand in vertical position. It shall be capable to measure the rail temperature correctly to the specified accuracy and tolerance within six minutes.
- 5.6 The supporting neck shall be fitted tightly to the moulded insert rail contact (the base) by suitable arrangements such as by threading, using adhesive etc.
- 5.7 The scale of the thermometer shall be engraved/etched or printed suitably on the stem.
- 5.8 The length of the thermometer shall be as per the drg.No.TM/0201. The bore of the capillary tube shall be uniform, throughout its length and shall preferably be elliptical, having a ratio of major axis to minor axis of not more than 2.5.

6.0 TECHNICAL FEATURES:

(a)	Overall length:	200 ± 5mm (including casing)
(b)	Overall length of capillary tube:	186 ± 2 mm
(c)	Least Count:	1.0 ⁰ C
(d)	Temperature Range :	- 5 ⁰ to + 85 ⁰ C.
(e)	Weight:	Within 120gms.
(f)	Temperature Recording Time:	Within six minutes.

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7.0 GRADUATION & FIGURING:

- 7.1 The scale shall be subdivided to the smallest division of the thermometer, i.e. 1 degree Celsius.
- 7.2 The graduations on the scale shall be of superior quality and clearly visible. The graduations shall not be faded/dimmed due to aging and shall be durable, firm and water/moisture resistant.
- 7.3 Length of graduation lines for every small division shall be 3 mm and length of graduation line for every fifth division shall be 5 to 6 mm. The small division will not extend across the bore but will be aligned in line with the bore when normally viewed. All short lines as well as long lines will be of equal and uniform thickness.
- 7.4 The graduations for every fifth division shall be extended on the right hand side. The main scale shall extend beyond the maximum nominal temperature as well as beyond the minimum nominal temperature by at least five small divisions.
- 7.5 The graduation lines shall be in a plane at right angle to the axis of the thermometer when the thermometer is viewed from the front in a vertical position and shall finish on an imaginary line parallel to the axis on the left hand side.
- 7.6 No graduation line shall lie within 10mm of any enlargement in the bore.
- 7.7 The graduation lines shall be clearly etched on the stem and filled with a suitable and durable quality black pigment. They shall be of uniform thickness of not more than 0.15mm.
- 7.8 The graduation at every ten small divisions shall be figured on the stem on the right side of the bore.
- 7.9 The figures shall be upright and shall be placed in such a way that they are bisected by an extension of the line. Alternatively, the figures shall be placed immediately above the extended line to which they refer.

8.0 TESTING & CALIBRATIONS:

The rail-thermometer shall be calibrated as per IS: 6274 –1971(Reaffirmed 2002). Every thermometer shall be checked (as per clause 3 of IS: 6274-1971(Reaffirmed 2002)) before proceeding for calibration. All the necessary corrections as stated in the above referred IS code shall be carried out.

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8.1 Tests at the time of supply (Acceptance Test):

The cost of acceptance tests shall be borne by the manufacturer/supplier. All arrangement to conducts acceptance tests shall be made by manufacturer/supplier.

The instruments in the consignment shall be subjected to following acceptance tests:

- i. Visual & Dimensional check.
- ii. Test for measuring range of temperature.
- iii. Accuracy test.
- iv. Magnetic flux test.
- v. Field test.

8.1.1 Details of acceptance tests:

(i) Visual & Dimensional check:

The dimensions of various parts of the thermometer (as mentioned in updated drg.No.TM/0201) shall be checked. The thermometer shall be visually examined for proper shape, soundness in appearance, and free from any defect that can be detected visually. All the samples shall be inspected by using a magnifying glass of linear magnification of at least ten for the following:

- (a) Detached thermometric liquid in the stem and at the safety chamber at top.
- (b) Impurities in bore – such as dirt, moisture etc.
- (c) Bad shape of bulb and safety chamber.

(ii) Test for measuring range of thermometer:

Arrangement shall be made by the manufacturer to test a temperature range of -5°C to $+85^{\circ}\text{C}$. The thermometers along with a standard and pre calibrated thermometer shall be placed in testing medium in such a way that only the bulbs get contact with the medium. Necessary calibration certificate for that standard thermometer, issued by a Govt. or Govt. recognized reputed test house shall be produced by the manufacturer before commencing this test. The temperature range shall be tested for both ascending and descending order and the results shall be compared with those of the standard thermometer. Such test shall be carried out twice with an interval of one hour in between two tests. No test certificate shall be acceptable for temperature- range test as the test shall be carried out at the factory premises of the firm who will arrange necessary equipments etc. required for the test.

(iii) Accuracy test:

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- (a) For each thermometers, the manufacturer shall produce calibration certificate containing details of tests, corrections and results. The certificate shall also mention the correction of reading, if any for entire range of temperature as specified before commencement of the calibration test.
- (b) (i) All thermometer shall be checked for their accuracy at 0⁰C, 20⁰C, 40⁰C, 60⁰C and 70⁰C using a comparator bath.
- (ii) For the purpose of testing of the thermometers, a testing bath shall be used. Following procedure shall be followed:
- The temperature of the bath shall be adjusted such that the standard thermometer reads 0 degree Celsius exactly.
 - The thermometer to be tested shall be loaded on a plate such that its bulb is dipped in the fluid completely but not more than 10 mm of the stem.
 - The temperature shall then be readjusted (if necessary) such that the thermometer shall be tested for 0⁰C.
 - The reading of the temperature of the standard thermometer shall be compared with that, recorded by the thermometers.
 - Above steps shall be conducted for temperatures of 20⁰C, 40⁰C, 60⁰C and 70⁰C respectively.
- (c) The thermometer shall have an accuracy of $\pm 1^{\circ}\text{C}$ when tested in a water/ oil bath without the protective casing by using a standard thermometer having a least count of 0.1⁰C.

(iv) Magnetic Flux test:

The magnetic flux density shall be measured with the help of calibrated flux meter/gauss meter. The minimum value of the flux density shall be 1800 gauss. The flux meter/gauss meter shall be arranged by the manufacturer.

(v) Field test:

Thermometers shall be tested at site. Thermometers shall be placed on rail top at running track/yard line of nearest railway station/yard /track. The thermometer shall be kept on rail for six minutes and temperature shall be recorded. At the same time the rail temperature shall be recorded with a standard and correct thermometer which shall be capable to measure correctly the rail temperature within six minutes. The readings of thermometers shall be compared. The standard thermometer shall be arranged by the firm.

8.1.2 For this purpose each thermometer shall be duly numbered before commencing the acceptance tests. The manufacturer shall issue certificate in respect of each instrument that the same conforms to the stipulated dimensions, accuracy and other requirements in the specification and the quality and grade of the raw materials used in manufacturing the thermometer conforms to the stipulations mentioned in the specification.

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8.1.3 The acceptance tests shall be carried out under witnessing of the consignee/inspecting official, if desired by him. The manufacturer shall produce all relevant documents as proof for conformity of quality of all the raw materials used, as well as procurement source, if desired by the consignee/inspecting officials.

8.2 Inspection:

The inspection of the instrument shall be carried out by the purchaser / zonal railway or any representative authorized by the purchaser/CTE of the zonal railway. The cost of inspection and testing shall be borne by the supplier/manufacturer. Copies of maker's test certificate guaranteeing the performance of the instrument shall be supplied in duplicate along with the delivery of each instrument.

The inspection of the instrument shall be carried out as per following Para:

8.2.1 Every thermometer of the consignment shall be subjected to visual and dimensional check as per Para 8.1.1(i) and magnetic flux test as per clause no. - 8.1.1 (iv).

8.2.2 Minimum 10% or part thereof of the consignment shall be tested for accuracy test.

8.2.3 In case more than test samples fail in the inspection in respect of Para 8.2.1 and 8.2.2 the total consignment shall be rejected.

8.2.4 Compliance of specification shall be verified at the time of inspection.

9.0 Warranty & AMC:

The thermometer failing or proving unsatisfactory in service due to defective design, material or workmanship within 12 months from the date of commissioning shall be replaced by supplier/manufacturer at his own expenses. If any design modification is made in any part of the equipment offered, the period of 12 month shall commence from the date of such modification.

During procurement of the thermometer, railways should go post-warranty AMC with the supplier for a pre-determined period as decided by the purchaser railway as per Comprehensive Guidelines on Procurement, Operation, Maintenance and Repair of Small Track Machine Repot no TM 227. This may be incorporated in the tender document as a condition of contract/Tender/Supply.

10.0 Service Facility and Spare Parts (including tools):

The manufacturer shall be responsible for subsequent availability of spares to ensure trouble free service for the normal life of the thermometer.

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11.0 Documentations:

Detailed operating manual, maintenance and service manual shall be specially prepared and two copies each of the same shall be supplied with each thermometer. The operating manual shall contain the trouble-shooting, maintenance instructions to be followed in the field during normal life of the thermometer.

Copies of the maker's certificate guaranteeing the performance of the thermometer should be supplied in duplicate along with the delivery of each thermometer.

12.0 Marking and Packing:

The thermometer shall be legibly and indelibly marked with:

- i) Name, initials, contact and trade-marks of manufacturer.
- ii) Measuring Range.
- iii) Serial number of thermometer.
- iv) Month & year of supply.

The instrument shall be supplied in proper packing as per best trade practice.

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