
British Standard

Heat meters

Part 3. Methods of test for pattern approval and
initial verification

Foreword

This Part of BS 7234 has been prepared under the direction of the Industrial-process Measurement and Control Standards Policy Committee.

Reference has been made in particular to BS 5728 : Part 3 'Methods for determining principal characteristics of single meters (including test equipment)', in the preparation of this document.

In matters relating to the testing of the electrical and electronic parts of a heat meter the requirements of relevant British Standards have been adhered to. Where no British Standard yet exists, for example for mains borne transients, the relevant IEC Publications have been followed, but modified as necessary to take account of the special requirements for testing heat meters.

Whilst the International Committee of Legal Metrology (OIML) International Recommendations on heat meters No. 75 'Heat meters' has been followed so far as practicable, there are many practical details of testing, equipment, and accuracy levels for the equipment where the OIML recommendation gives no guidance. In such cases the committee has followed advice proffered by UK experts in these specialisms.

This British Standard is published in three separate Parts:

- Part 1. Specification: general requirements
- Part 2. Specification for installation
- Part 3. Methods of test for pattern approval and initial verification

It has been assumed in the drafting of this British Standard that the execution of its provisions is entrusted to appropriately qualified and experienced people, for whose guidance it has been prepared.

BSI Committee PCL/2, whose constitution is shown at the end of this British Standard, takes collective responsibility for its preparation under the authority of the Board of the Institution. The Committee wishes to acknowledge the personal contributions of Mr. P. Harrison.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

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Method

1 Scope

This Part of BS 7234 describes the methods for testing heat meters to verify compliance with the pattern approval and initial verification requirements given in BS 7234 : Part 1.

The test methods and equipment described in this Part of BS 7234 are for the full pattern approval tests as specified in clause 7 of BS 7234 : Part 1 : 1990. The initial verification tests are a subset of the pattern approval tests and are specified in clause 8 of BS 7234 : Part 1 : 1990.

The latter involve tests according to clauses 4 to 6, but not clauses 7 to 12, of this Part of BS 7234.

The form and contents of the test report on the pattern approval tests are described, as well as those of the initial verification register.

NOTE 1. A summary of requirements and permitted tolerances in the measurement of physical quantities associated with heat meter test methods and test equipment is given in appendix A.

NOTE 2. The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this British Standard, the definitions given in BS 7234 : Parts 1 and 2 apply together with the following.

2.1 calibrated reference device. That part of a test facility embodying a standard, and against which the readings of the instrument on test is compared.

The standard has been calibrated against a standard or standards of known and greater precision, thus establishing its traceability.

In the testing of a heat meter a calibrated reference device may be used for checking temperature, volume or mass flow, etc.

2.2 meter factor. The relationship between meter output and the quantity passed through a flowmeter.

For the flow sensor of a heat meter this is expressed in units of output, for example pulses per cubic metre or kilogram, at the temperature and pressure of the test.

3 Requirements common to all tests

3.1 General rules concerning the test installations and their locations

3.1.1 Freedom from spurious influences. Test rigs shall be so designed, constructed and used that the performance of the rig itself shall not contribute significantly to the test error. To this end, high levels of rig maintenance and adequate supports and fittings, preventing vibration of the meter on test, the test rigs and their accessories are necessary.

It shall be possible to carry out the test readings rapidly and easily.

3.1.2 Location. The location chosen for the tests shall be isolated from any other activity, e.g. manufacture or repairs, or disturbing influence, e.g. vibration, electrical or electromagnetic noise.

3.1.3 Group testing of heat meters. Meters shall be tested individually or in groups. In the latter case the individual characteristics shall be precisely determined. Interaction between heat meters and between test rigs shall not be significant.

When heat meters are tested in series, the pressure of the heat conveying liquid shall be sufficiently high to ensure that cavitation cannot be present at any point in the heat meter (including temperature probes), at the temperatures of the test.

3.1.4 Traceability of the instrumentation used during testing. All instruments used in testing to determine that a heat meter conforms with the requirements of BS 7234 : Part 1, shall be traceable to the national, and hence international, primary standards of mass, length, time, temperature, pressure, frequency, etc.

3.2 Laboratory ambient conditions

The ambient conditions in the test laboratory shall be agreed between the manufacturer and certification body. Conditions are usually within the following ranges.

- (a) laboratory air temperature: 15 °C to 35 °C;
- (b) atmospheric pressure: 680 mbar* to 1060 mbar;
- (c) laboratory air humidity: 45 % to 75 %.

The electromagnetic background noise level shall be as follows:

- (1) field strength: < 1 V/m;
- (2) frequency range: 0.1 MHz to 1500 MHz.

3.3 Test reference conditions

The test reference conditions should be as given below, as appropriate for the various tests and unless otherwise specified, shall apply:

- (a) mains supply voltage: nominal voltage ± 2 %;
- (b) mains supply frequency: nominal frequency ± 2 %;
- (c) battery voltage: that of a new battery in service under normal operating conditions.

3.4 Test heat-conveying liquid quality

For all tests the heat-conveying liquid shall be water, unless otherwise specified.

The water shall be double ion exchanged drinking water filtered to 10 μm particle size.

After the ion-exchange treatment the conductivity of the treated water at 20 °C shall not exceed 5 $\mu\text{S/cm}$.

The electrical conductivity of the water shall be then adjusted to lie between 10 $\mu\text{S/cm}$ and 20 $\mu\text{S/cm}$ by the addition of sodium hydroxide (NaOH).

*1 mbar = 100 N/m² = 100 Pa.

4 Pressure tests

4.1 Principle

The heat meter (flow sensor, temperature probe pipe fittings, with temperature probes fitted) is subjected to a hydraulic pressure test for a specified time and any signs of leakage, seepage or damage are noted. The pattern approval test and the initial verification test differ, and are specified separately in **4.3.1** and **4.3.2** respectively.

4.2 Precautions to be taken during the test

The test rig shall be leakproof, and personnel shall be shielded from the risk of scalding by hot water or steam, in the event of component or meter-on-test failure.

The test rig and the meter shall be adequately cleared of air by bleeding.

Pressurizing shall be carried out gradually without pressure surges.

4.3 Procedures

4.3.1 Pattern approval test. Subject the flow sensor of the heat meter and its temperature probe pipe fittings with probes fitted, to the following hydraulic tests.

- (a) An applied hydraulic pressure of 1.6 times the nominal pressure applied for a period of 15 min at a temperature of 10°C ($\pm 5^{\circ}\text{C}$) less than the maximum temperature of the working temperature range.
- (b) An applied hydraulic pressure of twice the nominal pressure, applied for a period of 1 min at a temperature of 10°C ($\pm 5^{\circ}\text{C}$) less than the maximum temperature of the working temperature range.

Report any leakage or seepage through the walls, or cracks or permanent distortion visible to the naked eye, or damage to the meter function.

4.3.2 Initial verification test. Subject the flow sensor of the heat meter, including the temperature probe pipe fittings with probes fitted, to an applied hydraulic pressure of 1.6 times the maximum admissible working pressure for a period of 1 min using cold water.

Report any leakage, seepage through the walls, cracks or permanent distortion visible to the naked eye, or damage to the meter function.

5 Measurement error tests

5.1 Introduction

BS 7234 : Part 1 stipulates that measurement error tests shall be conducted on heat meters either as complete or as combined instruments. The test methods and equipment required differ for the two categories of instrument. The methods and equipment detailed in this Part of BS 7234 are given as examples capable of giving the required accuracy levels. Other methods may be used provided the accuracy levels stipulated in this Part of BS 7234 are attained.

5.2 Principle

The measurement error of the heat meter is checked by comparing the indications of the heat meter under test or its subassemblies, against the indications of calibrated reference devices.

5.3 Test equipment

5.3.1 Test circuit for heat meters categorized as complete instruments. A suitable test circuit used for determining the measurement errors of heat meters categorized as complete instruments is described in appendix B.

NOTE. The use of the test circuit is not confined to measurement error tests. It may be used in the tests listed in clauses **8**, **9**, and **10**, whether the heat meter to be tested is a complete or a combined instrument.

5.3.2 Test equipment for subassemblies of heat meters categorized as combined instruments

5.3.2.1 Flow sensor. A test rig constructed for the calibration of hot water meters in hot water is used to determine the relationship between flowrate, temperature, pressure and the output signal of the flow sensor subassembly.

A suitable rig is described in appendix C.

5.3.2.2 Calculator with temperature probes. Two accurately regulated temperature baths provide the source of supply of heat-conveying liquid to the two temperature probe pipe fittings with temperature probes, of the heat meter.

The temperature of the liquid flowing through the temperature probe pipe fitting is measured immediately upstream and downstream of it by traceably calibrated thermometers.

The simulated input signal from the flow sensor is supplied to the calculator, either by an appropriate electrical or by a mechanical input, after tests on the flow sensor have determined what the correct values for the simulated input shall be.

If the calculator and temperature probes are deemed separable (see clause **6.2** of BS 7234 : Part 1 : 1990), the temperature probe pipe fittings with temperature probes may be calibrated with an accurately regulated temperature bath(s).

The calculator is then tested by applying simulated inputs to its temperature probe terminals, and an appropriate simulated input to the flow sensor connection of the calculator, after it has been determined by tests on the temperature probes and the flow sensor, what the correct values of the simulated inputs shall be.

5.4 Method of use and precautions to be taken in using a test circuit for measurement error tests

5.4.1 Procedure. The test circuit described in **5.3.1** and appendix B may be used in two slightly different ways to determine the error curves of a heat meter.

- (a) *Conventional method.* Run the test circuit at the desired levels of pressure, temperature, temperature difference and heat-conveying liquid flowrate, under constant conditions for a measured time. Ensure the measured time is sufficiently long for the indications of the heat meter on test to be large enough to ensure

that the reading accuracy complies with **3.4.7** of BS 7234 : Part 1 : 1990.

NOTE. At low powers and for heat meters with coarse verification scale intervals, the time to amass an adequate number of digits on the indicating device of the heat meter may be uneconomically long.

(b) Pulse interpolation method

NOTE 1. The problem mentioned in the note to (a) is overcome by the introduction of a precise timer (preferably an electronic digital timer) into the test circuit.

Measure under constant conditions, and at the desired levels of pressure, temperature, temperature difference, and flowrate, the time between changes of digit of the least significant indicating element.

NOTE 2. This may be done visually, or if suitable the heat meter on test may be adapted to trigger the timer automatically. Provided the test circuit conditions remain constant, the time between digit movements of the indicating device should also remain constant.

Note the heat meter reading in the usual manner, after calibration of the reference flowmeter in the test circuit, and start the timer. After a relatively short period of time, (depending on the precision of the determination of the time interval between pulses), take the heat meter reading once more and stop the timer. Use the test duration indicated by the timer in the calculation of the 'theoretical' heat delivered by the test circuit. Calculate the number of whole pulses and decimal fractions of a pulse that the heat meter has registered in this time by dividing the test duration by the time between digits. Determine the heat meter error (for the particular conditions of flow and temperature, etc.) by comparing the refined heat meter reading with the theoretical heat delivered.

NOTE 3. This method gives a higher precision than would be the case when using the conventional method which uses whole numbers of digits only in the calculation of the error.

Whichever method is employed, repeat the test at different flowrates, and different temperatures of the 'hot' and 'cool' loops within the working specification of the meter on test. Determine the error for each test point and generate a family of curves, usually giving relative error plotted against flowrate for a constant temperature and temperature difference of the temperature probes.

NOTE 4. Only with a comprehensive set of error curves available is it practicable to determine if the maximum permissible error requirements of BS 7234 : Part 1 are being achieved.

5.4.2 Overall error of the method using a test circuit for measurement error tests. For pattern approval and initial verification, the total error in the method used for the determination of the measurement error of a heat meter shall not exceed 1/10 of the relevant maximum permissible percentage error of the heat meter, or 1 W, whichever is the greater.

5.4.3 Major factors affecting measurement error tests

5.4.3.1 General. Variations in the pressure, flowrate, and temperature in the test circuit, and uncertainties in the precision of measurement of these physical quantities and those of time and volume, are the major factors affecting the measurement error test results. **5.4.3.2** to **5.4.3.6**

specify the stipulated tolerances on these physical quantities.

5.4.3.2 Pressure. The pressure shall be maintained at a constant value throughout the test at the chosen flowrate. The pressure upstream of the heat meter(s) on test shall not vary by more than 10 %.

The maximum uncertainty in the measurement of pressure shall be 5 % of the measured value. Pressure at the entrance to the meter on test shall not exceed the maximum admissible pressure for the heat meter. Pressure at the exit of the meter on test shall be sufficiently large to prevent local cavitation within the meter (see also **3.1.3**).

5.4.3.3 Flowrate. The flowrate shall be maintained constant throughout the test at the chosen value.

The relative variation in the flowrate during each test shall not exceed ± 2.5 % (obtained from individual determinations of flowrate taken at regular intervals during the progress of the test).

The flowrate value used in plotting the error curves shall be the average value obtained over the total period of the test.

5.4.3.4 Temperature. During a test the temperature of the water through the 'cool' and 'hot' loops respectively shall not change by more than 0.5°C at any measuring point.

The maximum uncertainty in the measurement of the temperature in either loop shall not exceed 0.1°C .

5.4.3.5 Time. The maximum uncertainty in the measurement of the duration of the time of a test shall not exceed 0.05 %.

5.4.3.6 Volume (mass). The maximum uncertainty in the measurement of the volume or mass of the water that has passed through the heat meter on test shall not exceed 0.5 %.

5.5 Method of use and precautions to be taken in using a test rig for flow sensors for measurement error tests

5.5.1 Procedure. Use the test rig described in **5.3.2.1** and appendix C for testing flow sensors of heat meters categorized as combined instruments.

NOTE. The method used varies slightly depending on the type of calibrated reference device embodied in the test rig, but essentially follows the following procedure.

Run the test rig at the desired pressure, temperature and flowrate under constant conditions. Read the output of the flow sensor during the period of time that the volume or mass of the flow is being measured by the calibrated reference device. Then compare the reading with the mass or volume measured by the calibrated reference device at the conditions of pressure, temperature and flowrate that exist in the test rig at the time of the test.

5.5.2 Overall error of the calibrated reference device of a test rig for flow sensors for measurement error tests.

For pattern approval and initial verification, the total error in the method used for the determination of the volume or mass of hot water passed through the flow sensor shall not exceed 0.5 %.

5.5.3 Major factors affecting the precision of the determination of the flow sensor meter factor

5.5.3.1 General. Variations in the pressure, flowrate, and temperature in the test rig and uncertainties in the precision of measurement of these physical quantities and that of the mass or volume of the calibrated reference device, are the major factors affecting the measurement error test results. **5.5.3.2** to **5.5.3.4** specify the stipulated tolerances on these physical quantities.

5.5.3.2 Pressure. The pressure shall be maintained at a constant value throughout the test at the chosen flowrate. The pressure upstream of the flow sensor(s) on test shall not vary by more than 10 %.

The maximum uncertainty in the measurement of pressure shall be 5 % of the measured value. Pressure at the entrance to the flow sensor on test shall not exceed the maximum admissible pressure for the heat meter. Pressure at the exit of the flow sensor on test shall be sufficiently large to prevent local cavitation within the flow sensor (see also **3.1.3**).

5.5.3.3 Flowrate. The flowrate shall be maintained constant throughout the test at the chosen value.

The relative variation in the flowrate during each test (not including starting and stopping) shall not exceed ± 2.5 % (obtained from individual determinations of flowrate taken at regular intervals during the progress of the test).

The flowrate value used in plotting the meter factor curves of the flow sensor shall be the volume passed during the test divided by the time.

5.5.3.4 Temperature. During a test the temperature of the water shall not change by more than 1 °C.

The maximum uncertainty in the measurement of the water temperature shall not exceed 0.2 °C.

5.6 Method of use and precautions to be taken in using test equipment for the error measurement tests of a calculator with temperature probes

5.6.1 Procedure. Use the test equipment described in **5.3.2.2** for testing the calculator with temperature probes forming a subassembly of a heat meter designated as a combined instrument.

Set the two temperature baths at the desired temperatures for the test and allow ample time to allow the hot water being circulated through the temperature probe pipe fittings with temperature probes to reach a stable temperature. Record the actual temperature of the two water baths as the mean of the two thermometers placed upstream and downstream of each temperature probe pipe fitting.

Feed the flow sensor simulated input to the relevant terminals of the calculator.

NOTE. This is the signal determined previously when the flow sensor of the combined heat meter on test was tested in its test rig at the temperature and pressure of the current tests in the 'cool' loop, and at the flowrate designated for the simulated input.

Determine the error by comparing the indications from the indicating device of the calculator at the end of the measured test duration with the indication that would be

given from the 'theoretical' heat calculated from the knowledge of the two temperatures, flowrate and the measured test duration of these tests.

Repeat the tests as required to cover the temperature and flowrate range of the heat meter on test, and generate the family of error curves.

5.6.2 Overall error of the method using test equipment for calculators with temperature probes

5.6.2.1 General. For pattern approval and initial verification, the total error in the method used for determining the measurement error of a heat meter shall not exceed 1/10 of the relevant maximum permissible percentage error of the heat meter, or 1 W, whichever is the greater.

5.6.2.2 Temperature. During a test the temperature of the water flowing through the temperature probe pipe fittings with temperature probes shall not change by more than 0.5 °C, at any measuring point.

The maximum uncertainty in the measurement of the temperature circulating through each temperature probe pipe fitting with temperature probe shall not exceed 0.1 °C.

5.6.2.3 Simulated flow sensor input. The actual value of the frequency of the simulated input shall not differ from that determined under the temperature, pressure and flowrate conditions of the test when the flow sensor was tested separately, by more than 0.05 %.

The peak/trough voltage and shape of the simulated flow sensor input shall not differ from that determined under the temperature, pressure and flowrate conditions of the test when the flow sensor was tested separately, by more than 0.05 % in voltage nor in any other dimension by more than 0.2 % when the traces of the two inputs are compared, for example, on a recording oscilloscope.

5.7 Method of use and precautions to be taken in using test equipment for the error measurement tests of a calculator with temperature probes (calculator and probes deemed separable)

5.7.1 Procedure. Use the test equipment described in **5.3.2.2** for testing the calculator with probes of a heat meter when the calculator and probes are deemed separable. Measure the relationship between temperature and output for each temperature probe. Set the two temperature baths at the desired temperatures for the test and when conditions have stabilized measure the output from the temperature probes individually. Repeat the tests at temperatures within the working temperature and temperature difference range of the heat meter on test. Tabulate or record on a graph the relationship.

Test the calculator temperature measurement circuit by applying to the temperature probe terminals a simulated input signal identical to the output signal determined for each temperature probe at the temperatures decided on for the test.

Test the calculator flow measurement circuit by feeding the simulated input to the flow sensor terminals of the calculator as described in **5.6.1**. Apply the simulated input signals to the temperature probe and flow sensor

terminals which correspond to the signals that the calculator would be receiving from its temperature probes and flow sensor when in use, over any part of the working temperature and flowrate range. Determine the error for each test point by comparing the 'theoretical' heat output with that indicated by the meter.

Repeat the tests as required to cover the temperature and flowrate range of the heat meter on test, and generate the family of error curves.

5.7.2 Overall error of the method using test equipment (calculator and probes deemed separable)

5.7.2.1 General. The requirements of **5.6.2.1** shall apply.

5.7.2.2 Temperature. The requirements of **5.6.2.2** shall apply.

5.7.2.3 Output of the temperature probes. The relationship of probe output (volts, resistance, etc.) against temperature shall be recorded for each test point over the working temperature range.

The maximum uncertainty in the measurement of the temperature probe output shall not exceed 0.01 %.

5.7.2.4 Simulated flow sensor input. The requirements of **5.6.2.3** shall apply.

6 Pressure loss tests

The pressure loss of a heat meter, as defined in clause 5 of BS 7234 : Part 1 : 1990, is obtained by the method described in clause 7 of BS 5728 : Part 3 : 1984.

This method of pressure loss testing is a reference method. Other methods may be used provided that the values of the pressure loss obtained are equal to those obtained by the reference method.

Cold water complying with clause 3.4 of this Part of BS 7234 shall be used for these tests.

7 Accelerated wear tests

7.1 Principle

A heat meter or its subassemblies is subjected to periods of functioning under severe operating conditions and then it is determined whether the meter error curve has been unacceptably affected by these operating conditions (see **7.2.4** of BS 7234 : Part 1 : 1990).

For the convenience of testing laboratories the periods of functioning during the tests can be divided up into periods of continuous operation of not less than 6 h.

7.2 Flow sensors with moving parts

7.2.1 Description of the installation. The test circuit described in appendix B or the test equipment described in appendix C is normally used for the accelerated wear tests of a flow sensor with moving parts.

However, if required, a special test facility may be constructed for this test, and shall comprise:

- (a) a heated water supply (e.g. tank, heater and pump);
- (b) pipework and fittings comprising, flow regulating means, one or two isolating devices, means for measuring the water temperature at the outlet of the flow sensor, and means for checking the pressure, flowrate and duration of the test.

If the pipework ends in the open air, the end shall be located at a higher level than the upper part of the flow sensor. The different fittings and devices shall not cause cavitation to occur in the facility.

7.2.2 Precautions to be taken. The meter (flow sensor) and connecting pipes shall be suitably bled of air.

7.2.3 Flowrate tolerance. The flowrate shall be kept constant throughout the test at the required value. The relative variation of the flowrate value during the test shall not exceed $\pm 10\%$ (except when starting and stopping).

7.2.4 Temperature tolerance. The variation in temperature of the water passing through the flow sensor on test shall not exceed $\pm 2^\circ\text{C}$ (except when starting and stopping).

7.2.5 Test timing tolerance. The specified test duration is a minimum value.

7.2.6 Procedure. Install the heat meter in a test circuit as described in appendix B or the test equipment described in appendix C, or the special test facility described in **7.2.1**. Subject the flow sensor to a flowrate of $1.5q_{\text{max}}$ at the upper limit of the working temperature range for a test period of 300 h.

Record the calibration curves of the heat meter and compare with the initial calibration curves taken before the test to establish that the limits specified in **7.2.6.1** of BS 7234 : Part 1 : 1990 have not been exceeded.

7.3 Temperature probes

7.3.1 Description of the installation. The test circuit described in appendix B is normally used for the accelerated wear tests of temperature probes for heat meters categorized as complete instruments; it may be modified as necessary by the addition of means to admit and mix cool water into the test loops to facilitate the cooling phase of the temperature test cycle.

The test equipment described in **5.3.2.2** may be used for the accelerated wear tests of temperature probes for heat meters categorized as combined instruments, whether the calculator with probes subassembly is deemed separable or inseparable. The equipment may be modified to facilitate the cooling phase of the test cycle.

However, if required, a special test facility may be constructed for these tests since less stringent temperature measurement accuracy is called for than in the measurement error tests, for which the test circuit and testing equipment mentioned in the preceding two paragraphs is primarily designed.

7.3.2 Precautions to be taken. The temperature probe pipe fitting and probes shall be suitably bled of air.

7.3.3 Flowrate value and tolerance. The flowrate through the temperature probe pipe fitting shall be greater than the $q_{\min.}$ of the heat meter and the relative variation of the flowrate values shall not exceed $\pm 10\%$ during the test period (except when starting and stopping).

7.3.4 Temperature measurement accuracy. The maximum uncertainty in the measurement of the temperature of the water flowing through the temperature probe pipe fitting shall not exceed 1°C .

7.3.5 Permissible rate of temperature change. The permissible rate of temperature change in the water flowing through the temperature probe pipe fitting shall not exceed $1^\circ\text{C}/\text{min}$.

7.3.6 Procedure. Install the temperature probe in the test circuit as described in appendix B, or in the alternative test facilities described in 7.3.1 paragraphs two and three.

In the case of complete instruments, or combined instruments where the temperature probes are not separable, perform the test on the complete instrument or the subassembly containing the temperature probes.

Immerse the temperature probes to their declared immersion depth and perform an initial calibration. Bring the temperature probes slowly up to the upper limit of the working temperature range and maintain them at this temperature for sufficient time for them to reach thermal equilibrium. Then slowly lower the temperature down to the lower limit of the working temperature range and maintain it at this temperature for sufficient time for the temperature probes to reach thermal equilibrium. Repeat this procedure 10 times.

Record the calibration curve of the temperature probe and compare with initial calibration curve taken before the test.

7.4 Calculators

7.4.1 Description of the installation. The test circuit described in appendix B is normally used for the accelerated wear tests of calculators for heat meters categorized as complete instruments. However a similar but simpler and less precise test facility may be specially constructed for this test if desired.

The test equipment described in 5.3.2.2, with certain additions to provide the simulated input from a flow sensor, may be used for the accelerated wear tests of calculators for heat meters categorized as combined instruments and where the calculator and probes subassembly are deemed inseparable.

In cases where the calculator and probes subassembly are deemed separable and the calculator is to be subjected to accelerated wear tests on its own, the equipment described in the last paragraph of 5.3.2.2 may be used for the tests.

7.4.2 Precautions to be taken. The electrical connectors between temperature probes and calculator, if separable, shall be carefully cleaned before connecting them together.

7.4.3 Flowrate tolerance. The actual or simulated input flowrate shall be kept constant at the required level throughout the test. The relative variation of the values during the test shall not exceed $\pm 10\%$ (except when starting and stopping).

7.4.4 Temperature tolerance. The actual or simulated input temperature shall be kept constant at the required level throughout the test. The variation of the values during the test shall not exceed $\pm 5^\circ\text{C}$ (except when starting or stopping).

7.4.5 Test timing tolerance. The specified test duration is a minimum value.

7.4.6 Procedure. Install the calculator in the test circuit as described in appendix B, or the relevant test circuit described in 7.4.1.

Test the calculator for 500 h at the upper limit of the power range. In the case of complete instruments or combined instruments where the calculator is not separable from the temperature probes, carry out the test on the complete instrument or on the subassembly containing the calculator.

Record the calibration of the calculator and compare with the initial calibration curve taken before the test.

8 Dry heat test

8.1 Principle

Heat meters functioning in a test circuit are subjected to tests in which the air temperature surrounding the heat meter is raised above the ambient temperature for a given time. During this time error checks are made on the heat meter to determine if changes in the error curve occasioned by the increased temperature are within stipulated limits. After cooling down, the meter is inspected to determine if the raised temperature has damaged the meter.

8.2 Description of the installation

The tests shall be conducted using equipment and procedures in accordance with Section four Test Bd of BS 2011 : Part 2.1B : 1977, 'Test for dry heat for heat-dissipating specimen with gradual change of temperature' and, if feasible depending on meter and test chamber sizes, under 'free-air' conditions.

8.3 Mounting of the heat meter in the test chamber

The heat meter shall be mounted in the test chamber in accordance with the manufacturer's instructions. The indicating device or other units if intended to be wall mounted, shall be attached to a board or boards 22 mm to 25 mm thick and be of a size 200 mm larger than the dimensions of the indicating device or other unit. The board, or boards shall be secured vertically in the test chamber.

The pipes connecting the heat meter temperature probe pipe fittings and flow sensor into the test circuit, and which contain the circulating heat-conveying medium, shall be thoroughly heat-insulated throughout their length.