

Guide to

Test methods for batch furnaces with metallic heating resistors

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Power Electrical Engineering Standards Policy Committee (PEL/-) to Technical Committee PEL/87, upon which the following bodies were represented:

- Association of Manufacturers Allied to the Electrical and Electronic Industry (BEAMA Ltd.)
- British Glass Manufacturers' Confederation
- British Industrial Furnace Constructors Association
- British National Committee for Electroheat
- British Steel plc
- Electric Trace Heating Industry Council (ETHIC)
- Electricity Association
- Energy Industries Council
- Engineering Equipment and Materials Users' Association
- Engineering Industries Association
- Health and Safety Executive
- Induction and Dielectric Heating Manufacturers' Association
- Institution of Electrical Engineers
- Lighting Industry Federation Ltd.

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National foreword

This British Standard has been prepared under the direction of the Power Electrical Engineering Standards Policy Committee. It is identical with IEC 397:1972 *Test methods for batch furnaces with metallic heating resistors*, including supplement IEC 397A:1975, published by the International Electrotechnical Commission (IEC).

It is being published at the request of the British Technical Committee on Electroheat (PEL/87), taking into account that IEC 519-1:1984 *General requirements* has been ratified by CENELEC and published as a European Standard (EN), and has been published as BS EN 60519-1:1993 *Safety in electroheat installations — Part 1: General requirements*.

The text of IEC 397A:1975, first supplement to IEC 397:1972, is marked by a sideline in the margin.

Cross-reference

International Standard	Corresponding British Standard
IEC 398:1980	BS 7684:1993 <i>General test conditions for industrial electro-heating equipment</i> (Identical)

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 16, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Section 1. General

1 Scope

This recommendation applies to industrial furnaces heated indirectly with metallic heating elements (e.g., for heat-treatment, hot-forming, etc.) in which the internal atmosphere is composed of air not intentionally modified.

This recommendation applies to batch chamber, bell, elevator, shaft, carriage, or to furnaces of any similar construction. These furnaces may be constructed either with or without forced air circulation.

This recommendation covers furnaces of low and very low voltage categories (below 500 V).

2 Object

The object of this recommendation is the standardization of testing conditions and methods to determine the essential parameters and technical data of the above-mentioned furnaces.

This recommendation does not contain a list of mandatory tests, and is not restrictive. According to need, tests necessary for the assessment of a furnace can be chosen at will from among those specified in the suggested list.

When needed, supplementary tests can also be made, though preferably in compliance with the standards in use in the countries concerned.

3 Definitions

The following definitions apply for the purpose of this recommendation.

For definitions of fundamental and general terms in the field of electro-heating, the reader should refer to Chapter 05: Fundamental definitions, and Chapter 40: Electro-heating applications, of IEC Publication 50: International Electrotechnical Vocabulary (IEV).

3.1

indirect resistance electric furnace

furnace in which the heat evolved by the Joule effect in the heating elements is transferred to the material to be heated

3.2

charge

total of materials to be heated at the same time in the furnace (IEV 40-10-005)

3.3

heating element

electric conductor with ohmic resistance, connected to the source of electric energy, in which the electric energy is transformed to thermal energy by the Joule effect

3.4

heating assembly

assembly of heating elements controlled, regulated or switched jointly

3.5

furnace temperature θ_i (°C)

the temperature at one or more specified points in the heated space of the furnace

3.6

rated maximum furnace temperature θ_n (°C)

the rated operating temperature in normal service of the furnace for which the furnace is designed. It is indicated on the nameplate of the furnace

3.7

external surface temperature of the furnace θ_s (°C)

the temperature measured at one or more determined points on the outer surface of the furnace

3.8**ambient temperature θ_a (°C)**

the temperature of air surrounding the furnace at a point where thermal radiation and natural convection from the furnace do not exert any influence

3.9**reference ambient temperature θ_r (°C)**

ambient temperature, to which all furnace characteristic data are referred. The reference ambient temperature is fixed at 20 °C

3.10**temperature-time variation (°C)**

the temperature variation at a given point in the furnace plotted against time

3.11**surface temperature of the furnace at thermal steady-state θ_{so} (°C)**

the temperature reached at thermal steady-state at a predetermined point on the external surface of the furnace

3.12**rated furnace voltage(s) U_n (V)**

the voltage(s) for which the furnace is designed. It (they) is (are) given on the nameplate

3.13**furnace power P (kW)**

power consumed by the heating elements of the furnace at a given time

3.14**furnace rated power P_n (kW)**

power consumption of the furnace at the rated furnace voltage, rated current, rated frequency and rated temperature

3.15**mean no-load input loss P_o (kW)**

the energy loss in kWh in unit time (in hours) at the rated temperature of the empty furnace in normal operating conditions in thermal steady-state. In this case, the power demand of auxiliary devices, determined for the heating assembly (e.g. fan), should be added to the furnace rated power

3.16**electric power input of furnace switched on in cold state P_f (kW)**

the input power at the moment of switching on the cold furnace

3.17**heating-up time t_p (h)**

the time necessary to heat a dried, empty, closed furnace from 20 °C at rated voltage so that the temperature measuring equipment indicates the rated furnace temperature

3.18**connected load P_{tot} (kW, kVA)**

maximum furnace power input measured at rated voltage

3.19**time for attainment of thermal steady-state t_{th} (min/h)**

the time between switching on the furnace in the cold state and attainment of thermal steady-state

3.20**thermal steady-state of furnace**

the thermal condition when all energy input is used to cover heat losses

3.21**cold furnace condition**

the thermal condition in which the temperature of the assembly of constructional elements of the furnace equals the ambient temperature

3.22**hot furnace condition**

the thermal condition when the rated temperature is reached

3.23**energy consumption E (kWh)**

the quantity of energy consumed by the furnace during a given time without charge

3.24**heating-up energy consumption E_A (kWh)**

the quantity of energy absorbed by the empty furnace between switching on the cold furnace and attainment of the thermal steady-state without charge

3.25**leakage current**

leakage current is the current which in normal operation flows from live parts of the installation or apparatus through or over the functional insulation to conducting parts not forming part of the working circuit when these last-mentioned parts are electrically connected to the middle point of the power system or to a directly earthed point of the network

Section 2. Technical tests**4 Types of tests and general test conditions****4.1 List of technical tests**

The following tests are to be carried out for the assessment of the electro-heating equipment containing a furnace:

- a) Electric breakdown test of furnace insulation (see Sub-clause 5.1);
- b) Measurement of the power input of furnace switched on in cold-state (see Sub-clause 5.2);
- c) Furnace temperature measurement (see Sub-clause 5.3);
- d) Temperature measurement at the external surface of furnace (see Sub-clause 5.4);
- e) Total energy consumption measurement (see Sub-clause 5.5);
- f) Rated heating input measurement (see Sub-clause 5.6);
- g) Heating-up time measurement (see Sub-clause 5.7);
- h) Mean no-load loss power determination (see Sub-clause 5.8);
- i) Determination of time necessary to reach the thermal steady-state (see Sub-clause 5.9);
- j) Temperature measurement of accessible furnace parts (see Sub-clause 5.10);
- k) Determination of rated temperature change during the control cycle (see Sub-clause 5.11);
- l) Leakage current measurement (see Sub-clause 5.12);
- m) Determination of furnace temperature variation during the cooling period (see Sub-clause 5.13);
- n) Determination of accumulated heat (see Sub-clause 5.14).

4.2 General conditions of test performance

See IEC Publication 398: General test conditions for electro-heating installations.

4.3 Particular conditions of technical tests

- a) Tests according to Sub-clause 4.1 are realized on a furnace without charge;
- b) Tests with charge are to be agreed upon between manufacturer and user;
- c) When the furnace has a mechanical or electric regulation, appropriate test methods should be agreed upon between manufacturer and user.