

Keywords: EGOLF; Technical Resolution; Fire Resistance; Fire Resistance tests; Fire Resistance Furnace; Furnace Instrumentation; Furnace Temperature Measurement; Furnace Control.

FIRE RESISTANCE TESTS

PROCEDURES FOR THE CHOICE, USE, CHECKING, MOUNTING AND REPLACEMENT OF INSTRUMENTATION USED FOR TEMPERATURE MEASUREMENT IN FIRE RESISTANCE TESTS



THE EUROPEAN GROUP OF OFFICIAL

LABORATORIES FOR FIRE TESTING

This document has been prepared by EGOLF Technical Committee TC2. Under the decision taken at the meeting of EGOLF Plenary on 16th September 1999, Resolution Number 118, all EGOLF member laboratories shall adopt and implement the decisions given within this Technical Resolution.

Copyright: No copying in any form without written permission from EGOLF

Issue Date: 25th April 2000

Reference No. EGOLF / TR / 2: 2000

EGOLF TECHNICAL RESOLUTION TR / 2

PROCEDURES FOR THE CHOICE, USE, CHECKING, MOUNTING AND REPLACEMENT OF INSTRUMENTATION USED FOR TEMPERATURE MEASUREMENT IN FIRE RESISTANCE TESTS

SCOPE: This document considers EGOLF procedures for the choice, use, checking and replacement of instrumentation used for temperature measurement when carrying out EN fire resistance tests on building elements and service installations, using the procedures of EN 1363, "Fire Resistance Tests". This EGOLF Technical Resolution is intended to be supplementary to EN 1363 and the specified EN Fire Resistance Test Standards.

This document covers the following instrumentation:

- Plate thermometers used for measurement of furnace temperature.
- Thermocouples used for measurement of unexposed surface, cavity and internal specimen temperatures.
- Roving thermocouples.
- Thermocouples used to measure ambient temperature.
- Thermocouples used to measure gas temperature in service installation tests [fire resistant ducts and dampers, smoke extraction devices etc. (defined in the appropriate test standard)].

The test procedures given in EN 1363-1, EN 1363-2, and specific EN fire resistance test standards, (see references below) shall be followed in all cases. This document addresses items of test detail relating to instrumentation used for temperature measurement when carrying out fire resistance tests according to EN standards, which are not fully addressed therein.

RESOLUTION: EGOLF member laboratories shall implement the decisions given within this document, in respect of the purchase, use, checking, mounting and replacement of instrumentation used for temperature measurement when carrying out fire resistance tests according to EN 1363-1, EN 1363-2, and specific EN fire resistance test standards.

REFERENCES:

EN 1363	Fire Resistance tests: Elements of building construction – Part 1 General requirements for fire resistance tests. Part 2 Additional requirements for fire resistance tests.
EN 1364	Fire Resistance tests for Non-loadbearing Elements [all parts].
EN 1365	Fire Resistance tests for Loadbearing Elements [all parts].
EN 1366	Fire Resistance tests for Service Installations [all parts].
EN 1634	Fire Resistance tests for Door and Shutter Assemblies [all parts].
ENV 13381	Contribution to fire protection by applied fire protection [all parts]
EGOLF SM1	Determination of the response time of thermocouples to be used for measurement of air or gas phase temperature in fire resistance and reaction to fire testing.

1 INSTRUMENTATION USED FOR FURNACE TEMPERATURE MEASUREMENT

The design, construction and conditions of use of the plate thermometer for measurement of temperature in fire resistance furnaces, during fire resistance tests, are fully specified within EN 1363-1.

2 INSTRUMENTATION FOR GENERAL TEMPERATURE MEASUREMENT

The instrumentation required for general temperature measurement in fire resistance tests and its specification to IEC 584-1 is fully described in EN 1363-1.

Further specific instrumentation requirements for general temperature measurement may be given in the various specific fire resistance test standards [see references].

3 THERMOCOUPLE SPECIFICATIONS

Use of type K, Ni/Cr. vs. Ni/Al, thermocouple wires, meeting the criteria of IEC 584-1 during fire resistance tests, is specified in EN 1363-1.

No specification for thermocouple accuracy or tolerance is given within EN 1363-1.

IEC 584-2 is recognised as the standard defining thermocouple accuracy. Therein are defined two tolerance classes 1, viz.

Tolerance class 1: $\pm 1.5^{\circ}\text{C}$ in the range $T = (-40^{\circ}\text{C}$ to $+375^{\circ}\text{C}$).
 $\pm (0.004 \times T)^{\circ}\text{C}$ over the range $T = (375^{\circ}\text{C}$ to 1000°C).

Tolerance class 2: $\pm 2.5^{\circ}\text{C}$ in the range $T = (-40^{\circ}\text{C}$ to $+333^{\circ}\text{C}$)
 $\pm (0.0075 \times T)^{\circ}\text{C}$ over the range $T = (333^{\circ}\text{C}$ to 1200°C).

DECISION: EGOLF member laboratories agree that they shall use only thermocouples or thermocouple wires of the accuracy specified in IEC 584-2 in fire resistance tests. The tolerance class of each type of thermocouple shall be that appropriate to the maximum temperature expected in use.

Therefore, type K thermocouples of tolerance class 1 shall be used for general temperature measurement over the temperature range -40°C to 1000°C and tolerance class 2 thermocouples be incorporated into plate thermometers for furnace temperature measurement over the temperature range -40°C to 1200°C .

4 CHECKS ON INSTRUMENTATION USED FOR TEMPERATURE MEASUREMENT

Procedures for checking the accuracy of new and previously used instrumentation used for temperature measurement in fire resistance tests are not specified in EN 1363-1. Accurate calibration of instrumentation for temperature measurement against reference standards traceable to national or international standards as specified in EN 45001 is deemed unnecessary. EGOLF members have decided to adopt following checks:

DECISION: EGOLF member laboratories agree that they shall apply the checks given in clauses 4.1, 4.2 and 4.3 of this decision on new and used instrumentation to be used for temperature measurement in fire resistance testing:

DECISION [continued]

4.1 Laboratory purchases “ready-made” thermocouples from the manufacturer / agent

Initial requirement for purchased “ready made” thermocouples

- ALL thermocouples shall be purchased from CERTIFIED production and be supplied with a CERTIFICATE OF CONFORMITY to specification [IEC 584-1 and IEC 584-2] by the manufacturer or merchant before use by the laboratory.

Initial checks on thermocouple assemblies incorporating “ready made” thermocouples

- Plate thermometers shall be checked according to the procedure given in Annex 1.
- Thermocouple assemblies for measuring unexposed surface temperatures (fixed and roving thermocouple assemblies) shall be checked according to the procedure given in Annex 2.

4.2 Laboratory purchases thermocouple wire to make own thermocouples

Note: Thermocouples of the steel alloy sheathed type [specified in EN 1363-1 for use in plate thermometers, measurement of gas temperature in service installation tests (where this type specified) and for measurement of ambient temperature] are unlikely to be “self-made” by laboratories and are not considered in this section.

This section, therefore, relates only to thermocouples to be used for the measurement of specimen exposed and internal temperature or to thermocouples incorporated into thermocouple assemblies to be used for measurement of unexposed surface temperatures (fixed and roving thermocouple assemblies).

Initial requirement for purchased thermocouple wire for “self-made” thermocouples and thermocouple assemblies

- Thermocouple WIRES shall be purchased from CERTIFIED production and supplied with a CERTIFICATE OF CONFORMITY to specification [IEC 584-1 and IEC 584-2] from the manufacturer or merchant before being used by the laboratory.
- “Self-made” thermocouples shall be CHECKED by the laboratory before use in testing, or incorporation into thermocouple assemblies and used in testing, using the procedure given in Annex 2.

Initial checks on thermocouple assemblies incorporating “self-made” thermocouples

- Thermocouple assemblies incorporating “self-made” thermocouples for measuring unexposed surface temperatures, (fixed and roving thermocouple assemblies), shall be CHECKED according to the procedure given in Annex 2.

4.3 In use checks on thermocouples and thermocouple assemblies incorporating “ready-made” and “self-made” thermocouples

- All thermocouples and thermocouple assemblies, including plate thermometers, incorporating “ready-made” or “self-made” thermocouples shall be checked by the laboratory for damage or corrosion by VISUAL INSPECTION and for malfunction or correct connection by an appropriate ELECTRICAL CONTINUITY method with application of heat, each time used.
- All thermocouples and thermocouple assemblies, including plate thermometers, incorporating “ready-made” or “self-made” thermocouples which are re-used in testing shall be subjected to the checks to determine continued good performance as prescribed in clause 6 of this document.

5 ASSEMBLY / POSITIONING OF INSTRUMENTATION USED FOR TEMPERATURE MEASUREMENT

5.1 Plate thermometers used for furnace temperature measurement

The fixing of the thermocouple and the assembly of the plate thermometer used for furnace temperature measurement is specified in EN 1363-1. The distribution of plate thermometers within the furnace is prescribed in either EN 1363-1 or in specific fire resistance test standards.

Information, giving additional detail to that given in EN 1363-1, relating to the specification of the materials to be used in the construction of the Plate Thermometer is provided in Annex 1 [section 2] to this document.

The procedure for mounting plate thermometers within fire resistance furnaces is not specified in EN 1363-1. Some suggestions for the mounting of plate thermometers and some possible modifications to its construction, without those suggestions being binding on members, are given in (Informative) Annex 3 to this document.

5.2 Thermocouples for general temperature measurement

The assembly and positioning of thermocouples to be used for measurement of general temperatures in fire resistance tests on building elements, service installations etc. is specified in EN 1363-1. Any additional requirements particular to specific fire resistance test standards are defined within those standards.

6 REPLACEMENT OF INSTRUMENTATION FOR TEMPERATURE MEASUREMENT

Instrumentation used for the measurement of furnace and general temperatures in fire resistance tests on building elements and service installations may require replacement as a result of ageing or damage in use.

EN 1363-1 prescribes the criteria for replacement of the thermocouple and insulation pad contained within the plate thermometer, for replacement of thermocouples attached to the exposed surface and for replacement of those used for measurement of internal and cavity temperatures.

EN1363-1 and associated specific fire resistance test standards do not state:

- The times at which “fixed” and “roving” thermocouple assemblies for measuring unexposed surface temperatures, and thermocouples for measurement of ambient temperature and low gas temperatures, e.g. in service installation tests, shall be replaced.

EGOLF members have agreed to the following decisions in respect of the replacement of such thermocouples.

DECISION: EGOLF member laboratories agree that:

- **“Fixed” thermocouple assemblies may be re-used, despite being mechanically attached to the surface by adhesive or other fixing, provided that they are not damaged on disconnection from the previous test specimen. Before re-use a CHECK shall be made to ensure that there is no adhesive left on the disc, that the disc and thermocouple are not damaged or corroded, that the disc is flat and that there is no malfunction. If re-used for more than five (5) tests checks shall be made using the procedure of Annex 2.**
- **“Roving” thermocouples need not be replaced unless they become damaged. A visual inspection shall be made every time before they are used in a test. Checks shall be made when they are used for more than twenty-five (25) tests, using the procedure of Annex 2.**
- **Ambient temperature and gas temperature thermocouples need not be replaced unless they become damaged Checks shall be made when they are used for more than twenty-five (25) tests, using the procedure of Annex 2.**

EGOLF TECHNICAL RESOLUTION TR / 2

ANNEX 1

PLATE THERMOMETERS

PERFORMANCE CHECKS AND MATERIALS OF CONSTRUCTION

METHOD FOR CHECKING THE PERFORMANCE OF PLATE THERMOMETERS

All thermocouples purchased or supplied for the manufacture of PLATE THERMOMETERS for use in fire resistance tests shall be supplied, by the thermocouple manufacturer or merchant, with a Certificate of Conformity to IEC 584-1 and IEC584-2 [tolerance class 2 – see clause 3].

The manufacturer of the plate thermometer (laboratory or otherwise) shall pass this Certificate of Conformity with the plate thermometer, for retention by the user laboratory.

Newly made / newly received plate thermometers shall be checked according to the following method:

WHAT: A minimum of 20 % from each batch of newly made / newly received plate thermometers shall be checked before use.

WHEN: Before any individual Plate Thermometer from each batch of Plate Thermometers is used in fire resistance testing.

HOW: The Plate Thermometer being checked shall be heated with a small flame (e.g. laboratory small flame or cigarette lighter) at the centre point of the plate.

The temperature recorded shall indicate a steep rate of temperature increase.

BY WHOM: By the laboratory.

ACCURACY: None required.

.....

SPECIFICATION FOR MATERIALS OF CONSTRUCTION

Plate thermometer sheet metal

The folded metal sheet from which the plate thermometer is made shall comprise a nickel alloy, e.g. **Inconel 600**®, which has a composition:

0.05 % Carbon C
15.5 % Chromium Cr
75.0 % Nickel Ni
8.0 % Iron Fe

Insulation pad material

The insulation pad material of which the plate thermometer is made shall comprise an inorganic insulation material of density $280 \pm 30 \text{ kg/m}^3$, e.g. **Rath CVS 121**®, which has a composition:

1.0 % Al_2O_3
72.0 % SiO_2
27.0 % CaO

.....

ANNEX 2

METHOD FOR CHECKING THE PERFORMANCE OF SELF MADE THERMOCOUPLES AND THERMOCOUPLE ASSEMBLIES

All thermocouples purchased or supplied for the manufacture of thermocouple assemblies and thermocouple wires purchased or supplied for the manufacture of self made thermocouples and thermocouple assemblies for use in fire resistance tests shall be supplied, by the manufacturer or merchant, with a Certificate of Conformity to IEC 584-1 and IEC584-2 [to the tolerance appropriate to its use – see clause 3].

The performance of self made thermocouples and thermocouple assemblies shall be checked before use in fire resistance tests according to the method given within this annex. This applies to:

- Self made thermocouples to be used for direct measurement of temperature.
- Self made thermocouples for incorporation into thermocouple assemblies to be used for measurement of unexposed surface temperature.
- Thermocouple assemblies made from “ready made” thermocouples, to be used for measurement of unexposed surface temperature.
- Thermocouple assemblies made from “self made” thermocouples, to be used for measurement of unexposed surface temperature.

WHAT: A selection of all new “self made” thermocouples, whether to be used directly or to be incorporated into thermocouple assemblies. This selection to comprise:

- 10% of all “self made” thermocouples in each batch made by the laboratory, or any other organisation on behalf of the laboratory, or for small batches, the first, middle and last thermocouple made.

A selection of all new “thermocouple assemblies”. This selection to comprise:

- 10% of all “thermocouple assemblies” in each batch made by the laboratory, or other organisation on behalf of the laboratory, or for small batches, the first, middle and last thermocouple assembly made. This applies, whether the thermocouple assemblies are made from “ready made” or “self made” thermocouples.

WHEN: Before each batch of self made thermocouples and / or batch of thermocouple assemblies is used in fire resistance testing.

HOW: The self made thermocouple or thermocouple assembly being checked shall be immersed in:

- Ice water made from distilled water
- Boiling distilled water.

The temperature recorded shall be compared to:

- The temperature of melting ice from distilled water; $t_{\text{melting}} = 0^{\circ}\text{C}$
- The temperature of boiling distilled water $t_{\text{boiling}} = 100^{\circ}\text{C} - 0,02857 \times (1013 - p_a)$ where p_a = atmospheric pressure (barometric pressure) in hPa.

Alternatively a furnace of the type described in EGOLF SM1 may be used and the temperature recorded compared to that of a reference thermocouple.

BY WHOM: By the laboratory or the manufacturer of the self made thermocouple and / or thermocouple assembly. In the latter case, the results obtained and a check certificate shall be provided to the laboratory by that organisation.

ACCURACY: The maximum permissible error of the thermocouple, appropriate to its use, as given in IEC 584-2 – see clause 3 shall be allowed. If the error recorded on any of the tested selection is greater than this limit then all self made thermocouples and thermocouple assemblies within the batch shall be tested. Any failing to meet the criteria shall be rejected.

ANNEX 3 [INFORMATIVE]

ASSEMBLY / POSITIONING OF PLATE THERMOMETERS FOR FURNACE TEMPERATURE MEASUREMENT

The fixing of the thermocouple (using a single spot-welded or screw-fixed steel strip) and the assembly of the plate thermometer used for furnace temperature measurement is specified in EN 1363-1. It is suggested that the inclusion of a second spot-welded or screw-fixed steel strip may provide additional support to the thermocouple and that this be permitted, provided that it is situated well away from the hot junction of the thermocouple.

It is suggested that plate thermometers may be mounted within the fire resistance furnace in the following manner:

According to EN 1363-1 Figure 1, a mounting socket, through which the thermocouple passes, is fixed to the top edge of the plate thermometer. It is suggested that this mounting socket should be made of stainless steel and be of internal diameter of about 7 mm and wall thickness of about 1 mm. It may be threaded (R1/4) internally (or externally).

To mount the plate thermometer within the fire resistance furnace the mounting socket may be attached to a stainless steel mounting tube, the length of which [including the length outside the furnace] depends upon the position of the plate thermometer in the furnace (see figure 2 of this document). The mounting tube may be in one or more sections.

Where this procedure is used, such mounting tubes should be of internal diameter sufficient to fit over the outside of the mounting socket (see figure 1 of this document, left hand drawing) or external diameter sufficient to fit inside the mounting socket (see figure 1 of this document, right hand drawing). The mounting tube may be fixed to the mounting socket by use of either "locking screws" or screw thread.

Where the stainless steel mounting tube is to be attached to the plate thermometer via a screwed fitting, the mounting tube should be rotated during assembly, not the plate thermometer, to avoid twisting the thermocouple wire and any compensation cable used.

Where compensation cables are used these must be in free air once outside the furnace.

.....

THE EUROPEAN GROUP OF OFFICIAL LABORATORIES FOR FIRE TESTING

REGISTERED OFFICE
LABORATORIUM VOOR AANWENDING DER BRANDSTOFFEN-
EN WARMTE-OVERDRACHT
OTTERGEMSESTEENWEG 711
B-9000 GENT
BELGIUM

Copies: available from EGOLF Registered Office

FIGURES

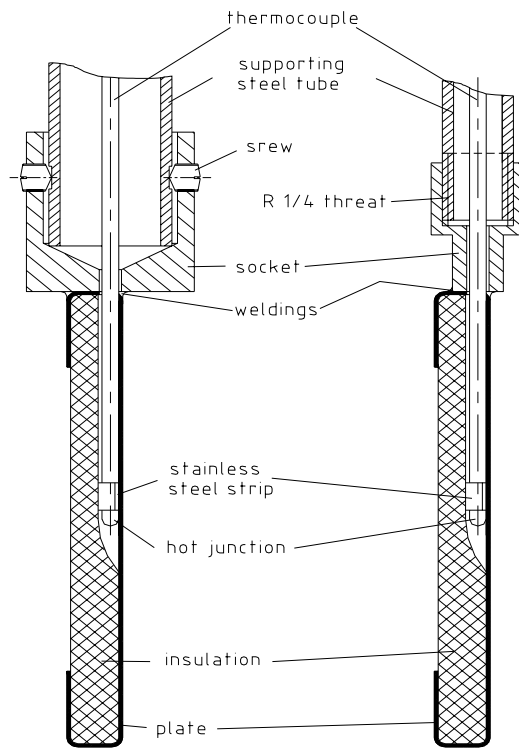


Figure 1: Examples of socket mounting

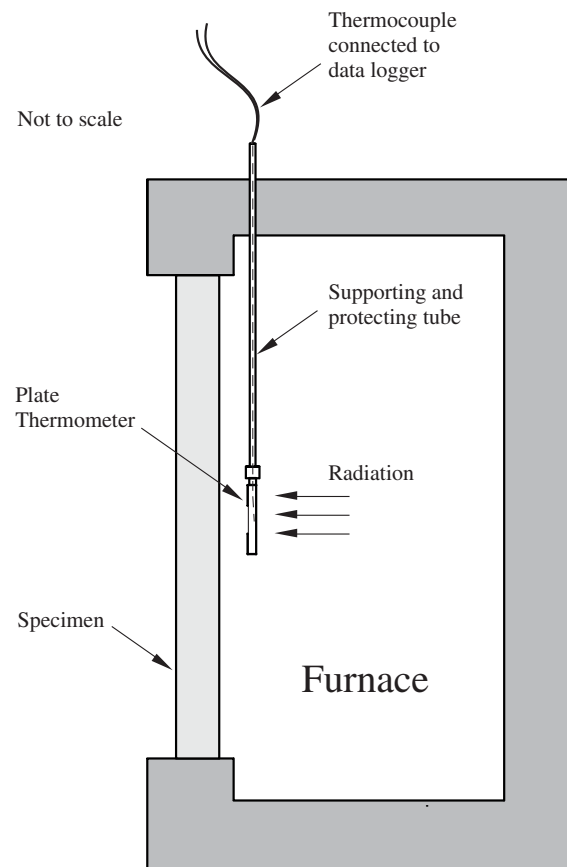


Figure 2: Example of plate thermometer location