

## **Title: Determination of thermal resistance by means of guarded hot-plate method up to 850 °C**

### **Abstract**

The European Construction Products Regulation (No. 305/2011) and harmonised thermal insulation product standards form a regulatory framework, which requires mandatory certification of insulation products before marketing in the EU. Thermal insulation materials are required to have a declaration of temperature dependent thermal conductivity up to the maximum service temperature for safety purposes and also for product conformity evaluation. In addition, a third of insulation material product technical standards demand reliable thermal resistance measurements above 650°C. Thus to meet this requirement the guarded hot-plate insulation material evaluation method needs to be extended to at least 850 °C.

### **Keywords**

Guarded hot-plate, Thermal Conductivity, Thermal Resistance, Thermal Insulation Products, Construction Products Regulation

### **Background to the Metrological Challenges**

Thermal insulation materials are used to enhance energy efficiency in many industrial plants and processes for example in energy production, petrochemical syntheses, metal foundries, and aerospace and aeronautical manufacturing. In 2010, an audit of insulation-related energy losses in EU industrial plants identified potential energy savings of 750,000 MWh/year, leading to a potential reduction of CO<sub>2</sub> emissions of 500,000 tonnes and at least €23.5 million in cost savings - all through the improved use of insulation products.

The EU Construction Products Regulation lays down harmonised rules for the marketing of construction products and covers the performance of insulation products. The regulation requires test laboratories to ensure insulation products meet specifications and that thermal conductivity testing is conducted throughout the EU to the specified normative standards therefore promoting fair trade and product improvements. However, new normative standards are required to extend insulation product certification from ambient temperature testing up to temperatures of at least 850 °C. CEN/TC89 WG 14 is presently working on a revision of the criteria for high-temperature measurements but due to a lack of data in the temperature range 650 °C to 850 °C it is unable to proceed.

Currently, there is a wide discrepancy in data reporting by thermal insulation product manufacturers due to the large variety of different standards issued by organisations such as ISO, CEN and the American Section of the International Association for Testing Materials (ASTM) etc., all covering the same thermal resistance/conductivity measurements at elevated temperatures. Therefore there is an urgent need for a harmonisation of these standards and a new EN standard to underpin EU regulations for high-temperature thermal insulation products has been identified by CEN/TC 89/WG 14. However, to enable conversion of the current Technical Specification CEN/TS 15548-1:2014 into a new EN standard, validated reference materials and verification of the guarded hot-plate method and its performance is required to at least 850 °C.

The EMRP project SIB52 'Metrology for Thermal Protection Materials' (Thermo) developed a European framework for measuring thermal resistance/conductivity of high-temperature thermal protection materials using the guarded hot-plate method. The SIB52 project's high-temperature thermal conductivity reference materials were used in a small scale NMI comparison to a maximum temperature 650 °C. However, this needs to be extended up to at least 850 °C with an extended comparison between both NMI/DI and accredited reference laboratories, as well as the development of improved statistical data for measurements of reference materials using the guarded hot-plate method for temperatures up to 850 °C.

## Objectives

Proposers should address the objectives stated below, which are based on the PRT submissions. Proposers may identify amendments to the objectives or choose to address a subset of them in order to maximise the overall impact, or address budgetary or scientific / technical constraints, but the reasons for this should be clearly stated in the protocol.

The JRP shall focus on the metrology research necessary to support standardisation for thermal resistance measurements using the guarded hot-plate method over the temperature range 100 °C to 850 °C.

The specific objectives are

1. To determine the performance limits of high temperature guarded hot-plate apparatus used in thermal resistance measurements and to establish test conditions for using these to meet the requirements of the new EN standard being developed by CEN/TC 89/WG 14. The target relative uncertainty of thermal resistance measurements is  $\leq 5\%$  for all temperatures as per the new EN standard's scope.
2. To develop validated calibration methods for temperature sensors used in guarded hot-plate measurements up to 850 °C. The goal is to establish reliable and accurate temperature measurements from 100 °C up to 850 °C for both absolute and differential temperature measurements.
3. To develop improved statistical data for measurements of reference materials using the guarded hot-plate method for temperatures up to 850 °C. This should include a EURAMET regional comparison of thermal resistance measurements using the guarded hot-plate method and existing reference materials developed in the EMRP project SIB52 Thermo. To demonstrate the value, in particular to end users, of extending thermal resistance measurements to 850 °C.
4. To contribute to the standards development work of the technical committees CEN/TC 89/WG 14 and other relevant standardisation working groups (e.g. CEN/TC 88/WG 10) ensuring that project outputs are aligned with their needs, communicated quickly to those developing the standards and to those who will use them (e.g. European material manufacturers, test laboratories and industrial end users of thermal protection materials) and in a form that can be incorporated into the new standard being developed.

Proposers should establish the current state of the art, and explain how their proposed research goes beyond this.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 0.6 M€, and has defined an upper limit of 0.8 M€ for this project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 30 % of the total EU Contribution to the project.

Any industrial partners that will receive significant benefit from the results of the proposed project are expected to be unfunded partners.

Proposers should establish the current state of the art, and explain how their proposed research goes beyond this. In particular, proposers should outline the achievements of the EMRP project SIB52 Thermo and how their proposal will build on those.

The proposed research shall be justified by clear reference to the measurement needs within strategic documents published by the relevant Standards Developing Organisation or by a letter signed by the convener of the respective TC/WG. EURAMET encourages proposals that include representatives from industry, regulators and standardisation bodies actively participating in the projects. The proposal must name a "Chief Stakeholder", not a member of the consortium, but a representative of the user community that will benefit from the proposed work. The "Chief Stakeholder" should write a letter of support explaining how their organisation will make use of the outcomes from the research, be consulted regularly by the consortium during the project to ensure that the planned outcomes are still relevant, and be prepared to report to EURAMET on the benefits they have gained from the project.

## Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the "end user" community, describing how the project partners will engage with relevant communities during the project to facilitate

knowledge transfer and accelerate the uptake of project outputs. Evidence of support from the “end user” community (e.g. letters of support) is also encouraged.

You should detail how your JRP results are going to:

- Address the SRT objectives and deliver solutions to the documented needs,
- Feed into the development of urgent documentary standards through appropriate standards bodies,
- Transfer knowledge to the European insulation material market sector.

You should detail other impacts of your proposed JRP as specified in the document “Guide 4: Writing Joint Research Projects (JRPs)”.

You should also detail how your approach to realising the objectives will further the aim of EMPIR to develop a coherent approach at the European level in the field of metrology and include the best available contributions from across the metrology community. Specifically the opportunities for:

- improvement of the efficiency of use of available resources to better meet metrological needs and to assure the traceability of national standards
- the metrology capacity of EURAMET Member States whose metrology programmes are at an early stage of development to be increased
- organisations other than NMIs and DIs to be involved in the work

## **Time-scale**

The project should be of up to 3 years duration.

## **Additional information**

- [1] CEN/CENELEC identified this topic as one of their priorities. Details are available at: [http://msu.euramet.org/current\\_calls/pre\\_norm\\_2017/documents/SRT\\_related\\_CEN\\_priorities/cen\\_priority\\_006\\_2017.pdf](http://msu.euramet.org/current_calls/pre_norm_2017/documents/SRT_related_CEN_priorities/cen_priority_006_2017.pdf)