EMRP Call 2012 – Open Excellence, Industry and SI Broader Scope

Selected Research Topic number: **SRT-i15**
Version: 1.0

Title: Metrology to enable high temperature erosion testing

Abstract

Major improvements in the manufacture of power generating plant and aero-engines will be made possible by the development of new materials that have improved resistance to high temperature particulate erosion. Research is needed to enable delivery of an improved metrological framework for high temperature erosion testing that will enable accurate comparison of the performance of new materials. The JRP should result in manufacturing industry being able to develop new power generation plant and aero-engine propulsion units with improved energy efficiency and durability.

Conformity with the Work Programme

This Call for JRPs conforms to the EMRP Outline 2008, section on “Grand Challenges” related to Industry & Fundamental Metrology on pages 12, 13, 14, 35, 36, 38, 40 and 42.

Keywords

Erosion, manufacturing industry, power generation plant, lifetime measurement.

Background to the Metrological Challenges

European companies lead the world in the development and production of power generating plant and aero-engines. Erosion and wear can dramatically reduce the efficiency and life of the high value components in these machines. In the power industry erosion costs an estimated US$150 million a year in lost efficiency, forced outages and repair costs. New materials with improved resistance to high temperature particulate erosion need to be developed to achieve major efficiency improvements. However, assessment of the erosion resistance of candidate materials and surface engineering solutions is hampered by a lack of metrology with respect to issues such as the measurement of damage, the temperature of the erosive particles and the supporting gas stream, the gas stream flow rates, erosive particle size and shape. An improved metrological framework for high temperature erosion testing will also be important for other applications in materials processing.

Europe has facilities for the measurement of high temperature particulate erosion, but these systems are limited in the particle velocity and temperature that they can achieve. There are also major limitations in the measurement uncertainties where current practice leads to large errors. For example, the velocity of erodent particles is measured with a twin disc test system where measurement errors are 20-30 %. Similarly, temperature measurements of erodent particles have unknown uncertainties. Particle size and size distribution define the mass of erodent particles, and thus, together with the particle velocity, the kinetic energy of impact for erodent particles. Often the poorly defined data from the materials suppliers is assumed to be correct. Particle shape defines the local contact geometry of impacts. However, there has been little work exploring the detailed relationship between shape and erosion behaviour. All of these measurements need major improvement.

Little modelling of long term performance of the high temperature erosion process has taken place. Therefore, prediction of material life-time is very uncertain. Major improvements in the applicability of modelling are required so that advances in prediction can be delivered. To enable better design of materials the behaviour of the materials needs to be better understood.

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Scientific and Technological 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 JRP-Protocol.

The JRP shall focus on traceable measurement and characterisation for high temperature erosion testing in order to enable accurate comparisons of the performance of new nanostructured and engineered materials to be carried out.

The specific objectives are

1. To measure the volume of wear through novel techniques including in-situ sensors that are capable of measuring the depth of damage to 1 µm over a 10 mm diameter area.
2. To measure and validate the mass loss change of samples to 1 µg accuracy.
3. To measure the velocity of high temperature erodent particles and their velocity distribution accurate to 1 ms^{-1}. The volume of damage in erosion is very dependent on the velocity of the erodent particles.
4. To measure the mean and distribution of the erosive particles size and shape. The influence of parameters, such as the angle of incidence and the geometry of the test system, should be investigated in relation to the results that are obtained.
5. To measure the temperature of high velocity erosive particles and the supporting gas stream at a temperature up to 1000 °C to an accuracy of 5 °C. The gas stream flow rate and its distribution should also be measured.
6. To model the high temperature erosion process to achieve a life prediction capability.

Proposers shall give priority to work that meets documented industrial needs and include measures to support transfer into industry by cooperation and by standardisation. An active involvement of industrial stakeholders is expected in order to align the project with their needs.

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

The total eligible cost of any proposal received for this SRT is expected to be around the 2.7 M€ guideline for proposals in this call. The available budget for integral Research Excellence Grants is 42 months of effort.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the “end user” community. This may be through the inclusion of unfunded JRP partners or collaborators, or by including links to industrial/policy advisory committees, standards committees or other bodies. Evidence of support from the “end user” community (eg letters of support) is encouraged.

You should detail how your JRP results are going to:

- feed into the development of urgent documentary standards through appropriate standards bodies
- transfer knowledge to the mechanical engineering, aerospace, energy, materials processing, oil and gas, and the materials handing sectors.

You should detail other impacts of your proposed JRP as detailed in the document “Guide 4: Writing a Joint Research Project”

You should also detail how your approach to realising the objectives will further the aim of the EMRP to develop a coherent approach at the European level in the field of metrology and includes 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 Member States and countries associated with the Seventh Framework Programme whose metrology programmes are at an early stage of development to be increased
- outside researchers & research organisations other than NMIs and DIs to be involved in the work

Time-scale

The project should be of up to 3 years duration.