EMRP Call 2013 – Energy and Environment

Selected Research Topic number: **SRT-g23**
Version: 1.0

Title: Traceable measurement of drive train components for renewable energy systems

Abstract

Highly loaded precision drive train components such as bearings, drive shafts, splines, generator parts and gearboxes are integral parts of wind, tidal and conventional power generation systems. They minimise the cost of equipment manufacture, improve operational efficiency and reduce operating costs. However, these benefits can only achieved, if the drive train components are reliable. Therefore, traceable measurement of such large and highly precise moving parts is required, with a particular focus on size and position parameters, the characterisation of surface, form and waviness, data density and filtering issues, use of large Coordinate Measuring Machines (CMMs), measurement and sampling strategies, product thermal stability and linking measurand characterisation with function.

Conformity with the Work Programme

This Call for JRPs conforms to the EMRP Outline 2008, section on “Grand Challenges” related to Energy and Environment on pages 8, 13, and 23.

Keywords

Coordinate metrology; large volume; wind power; tidal power; performance verification; traceability; energy generation; drive train components; gear metrology

Background to the Metrological Challenges

Drive train components are used to transmit high power to generators. Smaller high speed generators are cheaper to manufacturer than large, slow speed generators and operate more efficiently. However the high torque from slow speed wind turbines in the input stages, coupled with large deflections and a significant range of operating loads, necessitates a highly accurate manufacturing measurement capability. Improvements in machine tool and measuring technology have improved the repeatability and reliability of manufacturing processes but the traceability and effectiveness of the measurement processes, the parameters measured and tolerances specified are not yet linked with the functional performance of the drive train components and thus, limit performance and reliability of drive train components for renewable energy systems.

Current standards specify the allowable dimensional, form and position deviations determined as 2D parameters, however drive train components such as bearings, splines and gears operate as a 3D surface during operation in wind, tidal and conventional power generation systems and therefore it is reasonable to assume that such 2D parameters do not properly characterise the 3D surface. At present there is no reliable way to measure, evaluate and interpret 3D parameters; data cloud approaches have been considered but not properly applied and validated.

The dynamic response of scanning probes used in CMMs to measure drive train components is not usually considered by end-users. Of particular importance is the response of the probe to waviness errors and other parameters established as relevant to premature failure of large workpieces and of excessive noise and vibration. The development of measurement standards designed to quantify probe performance would establish whether CMMs are suitable for measuring these parameters.

In order to provide accurate measurements, validation of the modelling of thermal affects (e.g. harsh environmental conditions) and how they influence parameters measured on large parts is required. This

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includes quantifying how size influences both workpiece and measuring machine thermal stability; establishing a temperature sensing methodology and recommending stabilisation times. Methodologies that use a combination of the measurement standards and a Virtual Measurement Process (VMP) to assess measurement uncertainty are also required for establishing traceability for large drive train components (i.e. 2 to 3 m in diameter).

Defining and quantifying the functional parameters that correlate to drive train parts such as gear performance in terms of stress and predicted noise and vibration is a key part of ISO 14253 but the methods to do this are currently lacking in conventional metrology. The development of traceable CMM measurements and new surface based parameters that are validated will support this and the use of drive train components in renewable energy systems.

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 the traceable measurement and validation of parameters affecting the reliability of drive train components used in renewable power generation.

The specific objectives are

1. To develop traceable CMM measurements for large drive train components. Such measurements should be transferrable to end-users and their compliance with ISO 14253 should be established.
2. Development of new measurement standards for reliable production-related measurements used in wind, tidal and conventional power generation systems. This should include the production of measurement standards for drive train components in harsh environmental conditions.
3. Determination of the measurement uncertainty for CMMs and workpieces in harsh environmental conditions. The effect of temperature variation on measurement uncertainty and stabilisation times should be determined as well as best practice guidance for end-users.
4. Validation of the measurement strategies used for large drive train components (>1.0 m) and the determination of the achievable measurement uncertainty.
5. To establish a VMP for CMMs for traceably measuring large drive train components (>1.0 m) following the Guide to the Expression of Uncertainty in Measurement (GUM). An assessment of the applicability of the VMP for end-users should be included.

These objectives will require large-scale approaches that are beyond the capabilities of single National Metrology Institutes and Designated Institutes. To enhance the impact of the R&D work, the involvement of the user community such as industry, and standardisation and regulatory bodies, as appropriate, is strongly recommended.

Proposers should establish the current state of the art, and explain how their proposed project goes beyond this and the iMERA-Plus JRP NIMTech ‘Metrology for New Industrial Measurement Technologies’.

EURAMET expects the average size of JRPs in this call to be between 3.0 to 3.5 M€, and has defined an upper limit of 5 M€ for any project. The available budget for integral Research Excellence Grants is 30 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 renewable energy and industrial 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.

Additional information

The references were provided by PRT submitters; proposers should therefore establish the relevance of any references.

[1] ISO 14253, Part 1-6: Geometrical Product Specifications (GPS) -- Inspection by measurement of workpieces and measuring equipment