EMRP Call 2013 – Energy and Environment

Selected Research Topic number: **SRT-g04**
Version: 1.0

Title: Validated inspection techniques for composites in energy applications

Abstract

The excellent mechanical properties, low weight, fatigue and corrosion resistance of fibre reinforced plastic (FRP) composites gives them considerable advantages in renewable energy (wind, wave and tidal), oil and gas and transport applications. The use of FRPs has the potential to reduce fossil fuel reliance, consumption and greenhouse gas emissions. However, full exploitation is hindered by the diverse range of defects and damage mechanisms that reduce the strength, stiffness and life of FRP structures. The development and validation of traceable procedures for novel inspection techniques with contrasting detection capabilities, will underpin the increased use of FRP for improved efficiency and reliability in energy related applications.

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 8/9 and 23/24/25.

Keywords

Non-destructive evaluation (NDE), fibre reinforced plastic (FRP) composites, wind, tidal, oil and gas, transport, validation, pre-standardisation, probability of detection (POD), defect detection, modelling.

Background to the Metrological Challenges

Non-destructive evaluation (NDE) techniques have been developed but few methods are used because standardised operational procedures are unavailable and because NDE is perceived to be too new, costly and complex. Also, there are no ISO NDE standards that are specific to defect detection in composites. Several ASTM composite NDE specific standards exist, but these are focussed on the aerospace sector. Widely applicable operational procedures, based on the comprehensive evaluation and development of each technique for detecting a range of defects typical to composites as used in wind, wave, tidal, oil and gas and transport sectors, need to be developed.

NDE is used to test high performance materials systems e.g. carbon fibre-reinforced plastics and metallic sandwich structures in the aerospace sector. The use of NDE in other sectors is not so straightforward: components are often thicker, more complex and variable in material quality. Also different types of damage and defects may be present. Existing procedures may be proprietary, too complex (requiring specialist knowledge) or even too simple.

NDE inspections are limited to visual inspection, tap testing, ultrasonic C-scan and X-ray radiography techniques and are not necessarily suitable for inspecting complex composite structures (e.g. wind turbine blades – bonded hybrid structures), and especially not for investigating structures in service.

Novel NDE techniques such as microwave, active thermography, laser shearography and phased array ultrasonics show significant potential. However these techniques require further development and there is currently insufficient knowledge of their sensitivity and reliability for inspection of complex composite constructions. There is a requirement to define detection limits and probabilities.

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 characterisation of novel non-destructive evaluation techniques and procedures for defect detection, location and sizing in composite structures.

The specific objectives are

1. To design and manufacture suitable natural and artificial reference defect artefacts representative of the materials and defects typically found in, and of concern to the renewable energy (wind, wave, and tidal), oil and gas and transport sectors.
2. To develop operational procedures, drafted in the style of CEN and ISO standards, for microwave, active thermography, laser shearography, and phased array ultrasonic techniques. The metrology objectives are to:
    i) establish the limits of detection for each NDE technique,
    ii) develop techniques for accurately sizing defects for the NDE techniques. The NDE results should be compared with independent characterisation techniques.
    iii) compare the merits of each non destructive evaluation technique (NDE) technique for different defect types found in a broad range of composite material systems using an objective probability of detection (POD) benchmarking framework.
3. To evaluate the POD methodology, based on modelling simulations with the aim of reducing the cost and time requirements of experimental POD trials.
4. To validate and refine operational procedures via intercomparison exercises and field trials in collaboration with NMIs and organisations from the renewable energy (wind, wave and tidal), oil and gas and transport sector supply chains. Defect artefacts to be inspected using the developed operational procedures

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.

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, oil and gas, and transportation 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.