European Partnership on Metrology
Call 2022 – Digital Transformation, Health, Integrated European Metrology, Normative and Research Potential

Selected Research Topic number: **SRT-r07**
Version: 1.0

Title: Determination of tritium content in solid samples

Abstract

Radioactive tritium is known to contaminate the materials that are used in the construction of nuclear facilities. However, it is not currently possible to accurately characterise the tritium content of this material. Therefore, metrology capability needs to be developed to enable its traceable measurement using representative solid samples. Advances are expected to lead to the development of new standards for use in the calibration of radioanalytical equipment (i.e. total combustion, total desorption, accelerator mass spectrometry) with validation being achieved via European interlaboratory comparisons.

Keywords

Absolute activity measurement, accelerator mass spectrometry, calibration, interlaboratory comparison, radioactive wastes, solid samples, standards, total combustion, total desorption, tritium

Background to the Metrological Challenges

Radioactive tritium is produced in tritium facilities and as a by-product in nuclear facilities. Its production can lead to the contamination of the construction materials that are used. Alloys, especially stainless steels, and pure metals have been closely studied with respect to permeation under simulated working conditions, and some good studies have been done on the sorption of tritium. In addition, metal particles (e.g. beryllium or wolfram) can occur as a by-product in fusion reactors and these particles could become contaminated with high amounts of tritium. The contamination of other solid materials, including polymeric materials, ceramics, glass, and concrete, which are also ubiquitous in the construction of nuclear facilities, have been less well studied. Therefore, in order to control this radioactive material, metrology capability needs to be developed to enable its traceable measurement in representative solid samples. For example, new absolute activity measurement methods need to be developed for pure beta emitters such as tritium.

In order to prepare standards, solid samples, which are representative of the materials used in the construction of nuclear facilities need to be contaminated with known amounts of tritium. This can be achieved using specific compounds that are labelled with tritium. For non-metallic samples, thermostable tritium labelled compounds (e.g. testosterone, polystyrene or polysiloxanes) have previously been used. For metallic samples, a new tritium source needs to be developed, consisting of metallic matrices containing nanometre scale clusters of metal tritides with controlled activity.

Calorimetry (only for high activity tritium sources), total combustion, total desorption and accelerator mass spectrometry are the main radioanalytical methods used to determine the tritium content of solid samples. At present, this equipment either remains uncalibrated or calibration is performed with non-compliant standards (i.e. for metallic samples). Therefore, new standards for solid samples need to be developed and used to determine the optimal parameters of the radioanalytical equipment and the detection efficiencies, including the preparation of thermal diagrams. In addition, interlaboratory comparisons need to be performed to establish the performance and limitations of the radioanalytical equipment and the new standards, with validation at national and European level.

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 development of metrology capability to enable the traceable measurement of tritium concentrations in solid samples.

The specific objectives are

1. To develop absolute activity measurement methods for pure beta emitters such as tritium.
2. To obtain solid samples (metals, concrete, moderators, composite materials) that are representative of the materials used in the construction of nuclear power plants. The non-metallic materials should undergo controlled contamination using thermostable tritium labelled compounds (e.g. testosterone, polystyrene or polysiloxanes). In addition, to develop a tritium source consisting of metallic matrices containing nanometre scale clusters of metal tritides with controlled activity. The contaminated solid samples should be suitable for use as standards.
3. To perform preliminary tests using the standards, prepared in objective 2, in order to determine the optimal parameters of the radioanalytical equipment (total combustion (TC), total desorption (TD), accelerator mass spectrometry (AMS)) and the detection efficiencies, including the preparation of thermal diagrams.
4. To organise and conduct comparisons in order to establish the performance and limitations of the radioanalytical equipment tested in objective 3 and the standards prepared in objective 2. In addition, to validate the standards, at national and European level, for use with TC, TD and AMS methods.
5. To facilitate the take up and long term operation of the capabilities, technology and measurement infrastructure developed in the project by the measurement supply chain (NMIs/DIs, calibration and testing laboratories), and end users (e.g. nuclear industry, regulators, ITER project, nuclear power plants, radioactive waste plants, associated small enterprises). The approach should be discussed within the consortium and with other EURAMET NMIs/DIs e.g. EURAMET TCs or EMN for Radiation Protection, to ensure that a coordinated and optimised approach to the development of traceability in this field is developed for Europe as a whole.

Joint Research Proposals submitted against this SRT should identify

- the particular metrology needs of stakeholders in the region,
- the research capabilities that should be developed (as clear technical objectives),
- the area for which the capabilities will be built (Green Deal, Digital Transformation, Health, Integrated European Metrology, Industry, Normative or Fundamental Metrology) and in which future main call the developed research capabilities are planned to be employed,
- the impact the developed research capabilities will have on the industrial competitiveness and societal needs of the region,
- how the research capability will be sustained and further developed after the project ends.

The development of the research potential should be to a level that would enable participation in other TPs.

Proposers should note that the programme funds the activity of researchers to develop the capability, not the required infrastructure and capital equipment, which must be provided from other sources.

EURAMET expects the average EU Contribution for selected projects in this TP to be 0.5 M€, and has defined an upper limit of 0.9 M€ for this project.

EURAMET also expects the EU Contribution to the external funded beneficiaries to not exceed 20 % of the total EU Contribution across all selected projects in this TP.

Any industrial beneficiaries that will receive significant benefit from the results of the proposed project are expected to be beneficiaries without receiving funding or associated partners.

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,
- Provide a lasting improvement in the European metrological capability and infrastructure beyond the lifetime of the project,
- Facilitate improved industrial capability or improved quality of life for European citizens in terms of personal health or protection of the environment,

- Transfer knowledge to the nuclear sector and the metrology community.

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 the Partnership 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.