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## **Publishable Summary for 20SIP02 FreeRelease**

### **Transfer of developed pre-selection and free release technology to decommissioning industries**

#### **Overview**

The aim of this project is to transfer the pre-selection and free release measurement technology, developed in the EMPIR 16ENV09 MetroDecom II project, to end-users (e.g. managers of shut-down nuclear power plants (NPPs) and waste decommissioning companies) with different requirements for e.g. throughput (i.e. the amount of measured waste per year) and to maximise the uptake of the technology. To achieve this, the developed measurement technology (including software and hardware) must be adapted according to different end-users' needs in terms of modularity, the categorisation of wastes and nuclear regulators' requirements, for commercial business.

#### **Need**

The first generation of nuclear power plants and reprocessing facilities are at the end of their working lives and they will need to be decommissioned and dismantled. Over 90 power plants are being decommissioned in the EU while 120 reactors will need to be decommissioned by 2030. The aim of the decommissioning process is to clear the site while minimising the risk to the public and the environment from the waste, which can only be successfully undertaken with safe and effective management of radioactive wastes using reliable measurement techniques. Two essential steps in the decommissioning process are the pre-selection of wastes for storage in a repository and the free release measurement. These needs are supported by the EU Council Directive 2011/70/EURATOM, where the need for new measurement techniques is stated in order to improve the safe and effective management of radioactive wastes. In the EMPIR 16ENV09 MetroDecom II project, a pre-selection and free release measurement facility was developed and constructed, and measurement, evaluation and calibration software were created. Procedures for the traceable calibration were developed. The modularity and flexibility of the system were seen to be important allowing the measurement of wastes to be tailored to end-users' needs. For the further uptake of the measurement technology, it is necessary that (i) the throughput of the measurement system is improved; (ii) the categorisation of wastes before the measurement campaign is performed and relevant calibrations included in the calibration software; and (iii) radionuclides of interest are selected by the end-user. All of the parameters mentioned above depend on the type and age of the nuclear reactor and the nuclear regulators' requirements. The company NUVIA a.s. as the pre-selection and free release measurement facility producer needs their business to fit the broad international market and the facility needs to be adopted by a broad community of end-users.

#### **Objectives**

The aim of this project is to transfer the pre-selection and free release measurement technology developed in EMPIR JRP 16ENV09 MetroDecom II to meet different end-users' requirements (throughput, categorisation of wastes, and national and European nuclear legislation) and to maximise the uptake of the technology by the nuclear decommissioning industry.

The specific technical objectives are:

1. To prepare a document for use in the modification and modularisation of the pre-selection and free release measurement facility's hardware and software that was developed in EMPIR JRP 16ENV09 MetroDecom II to meet the primary supporter's and different end-users' requirements for (i) throughput, i.e. the amount of measured waste per year, (ii) the categorisation of wastes i.e. waste shape, material and radionuclides of interest and (iii) national, European and international nuclear legislation.
2. To provide a tailored detailed description of the pre-selection and free release measurement facility for each interested end-user, including (i) the number of measurement modules, (ii) individual calibration software, (iii) radionuclide libraries, (iv) the determination of pre-selection coefficients and (v) the calculation of legislative criteria. To train stakeholders on how to operate the facility, including demonstrations of the hardware and the measurement and calibration software.

## Results

*Objective 1: Document on the modification/modularisation of the pre-selection & free release measurement facility's hardware and software*

During the first period of the project, over thirty persons from the decommissioning and nuclear energy industry, waste management companies and European metrology institutes were contacted to obtain information on the pre-selection and free release measurement needs in different types of nuclear facilities. A questionnaire was prepared and sent to more than ten potential end-users from nuclear facilities across Europe, in order to obtain information about their specific needs for pre-selection and/or (current or future) free release measurement. These potential end-users cover the most important types of power nuclear reactors, i.e. pressurized water reactor (PWR), boiling water reactor (BWR) high-power channel-type reactor (RBMK), research reactors, submarine reactors, and tokamak fusion experimental reactor. The completed questionnaires were obtained from Czech PWR nuclear power plants, Spanish BWR nuclear power plant, Lithuanian RBMK nuclear power plant, Belgian PWR research nuclear reactor, two Estonian PWR submarine nuclear reactors, and UK tokamak experimental reactor, to get information about the type and amount of measured waste, radionuclides of interest, and used nation, European and international legislation.

During the second period of the project, the received questionnaires were evaluated and the document for use in the modification and modularisation of the pre-selection and free release measurement facility's hardware and software was prepared. This document contains information on (i) throughput, i.e. the amount of measured waste per year, (ii) the categorisation of wastes i.e. waste shape, material and radionuclides of interest and (iii) national, European and international nuclear legislation. The document will enable the Primary Supporter to offer its product to the wider decommissioning community and to commercialise this new technology and knowledge during and after the completion of this project.

During the third period of the project, the deliverable D1 was submitted to EURAMET by the project coordinator and accepted. The IEC TC 45 'Nuclear Instrumentation', ISO TC 85 'Nuclear Energy, Nuclear Technologies, and Radiological Protection', ICRM Working Group for Gamma-ray spectrometry and EURAMET TC-Ionising Radiation were informed about the findings described in D1.

*Objective 2: Description of the pre-selection & free release measurement facility for each interested end-user*

During the third period of the project, the list of 7 European end-users interested in adopting the new pre-selection and free release measurement technology was written. The report summarizing the end-users' requirements concerning the measurement facility's capacity (throughput), waste categories, radionuclides of interest and legislative requirements was prepared and sent to the Primary supporter.

NUVIA as the Primary supporter has started preparation of the document including a detailed description of modified pre-selection and free release measurement facility for each interested end-user.

## Impact

*Outcomes for the Primary Supporter and industrial and other user communities*

This project is creating impact by enabling the Primary Supporter to generate uptake in the wider nuclear energy industry and decommissioning community of the pre-selection and free release measurement technology, developed in EMPIR JRP 16ENV09 MetroDecom II, for the unification of waste measurements in nuclear facilities. The amount of waste material waiting for measurement at shut-down and operational nuclear facilities is a huge problem for the nuclear power industry. This project will help by providing a high level of ionising radiation metrology, in terms of measurement uniformity and correctness, to the unification of pre-selection and free release measurement, combined with the high capacity and modularity of the developed system.

The document prepared for use in the modification and modularisation of the pre-selection and free release measurement facility's hardware and software enables the Primary Supporter to offer its product to the wider nuclear energy industry and decommissioning community and to commercialise the new pre-selection and free release of waste technology. Based on this document, the Primary Supporter in cooperation with the project partners will prepare a complex solution for pre-selection and free release measurement with a detailed description of the pre-selection and free release measurement facility (hardware and software) for each interested end-user.

This will allow the interested end-users to rapidly adopt the new pre-selection and free release measurement technology and to solve their problems, such as non-spectrometric measurement, insufficient throughput, insufficient sensitivity and traceable calibration, which are associated with the huge amounts of nuclear wastes waiting for measurement.

#### *Outcomes for the metrology and scientific communities*

European NMIs and DIs, TC-IR, ICRM Working groups and NIST were informed about new measurement technologies for waste measurement including new methods for traceable calibration of large measuring geometries (drums, boxes, big bags) with different types of waste materials, based on validated Monte Carlo calculations.

The head of the radioactivity measurement group at NIST (US National Institute for Standardization and Technology) was informed about the developed facility for pre-selection and free release measurement and asked to apprise responsible persons in the US of this new technology.

The pre-selection and free release measurement facility were presented and demonstrated in March 2023 to contact persons of EURAMET TC-IR (Technical Committee for Ionizing Radiation) during the meeting at CIEMAT (Madrid), where the facility is installed. The EURAMET TC-IR contact persons were asked to apprise relevant persons in their countries of the new technology for pre-selection and free release measurement of wastes in nuclear facilities.

#### *Outcomes for relevant standards*

International standardisation committees and working groups IEC TC 45 'Nuclear Instrumentation', ISO TC 85 'Nuclear Energy, Nuclear Technologies, and Radiological Protection', ICRM WG for Gamma-ray spectrometry and EURAMET TC-IR were informed about the project findings to help them to update existing or to create new documentary standards in the field of nuclear technologies, e.g. IEC 61452:2021, Calibration and use of germanium spectrometers, IEC 63048: 2020, Mobile remotely controlled systems (MRCS) for nuclear applications, IEC 63048: 2025, MRCS specific requirements, ISO 24389-1: 2023, Management of radioactive waste from nuclear facilities, ISO/AWI: 83345, Application of Knowledge Management to Radioactive Waste Management.

#### *Longer-term economic, social and environmental impacts*

##### *Economic*

The total cost of decommissioning one nuclear unit is in the order of hundreds of millions of Euros. The typical volume of waste material generated during the decommissioning of a single nuclear unit is in the order of hundreds of thousands of tonnes. Typically, a third of these waste materials contain a high proportion of metals that are potentially or actually contaminated. Approximately 10 % of the contaminated proportion ends up in different types of repositories, while the rest is decontaminated, measured, and released into the environment or sent for recycling. The free release measurement enables safe release of the materials into the environment instead of expensive storage in repositories and therefore big savings in the order of tens of millions of Euros. Also, the quantity of incorrectly released materials will be lowered and possible trade disputes between waste producers, scrap companies and metallurgical works will be less likely at national and international levels.

##### *Environmental*

Uncertainties on radioactivity measurements in waste materials may result in large volumes of materials being incorrectly released into the environment, or being needlessly placed in repositories. New measurement technologies for pre-selection and free release measurement, developed in EMPIR JRP 16ENV09 MetroDecom II, are able to lower such uncertainties and prevent unnecessary contamination of the environment by radionuclides.

##### *Social*

Although the nuclear industry has developed solutions ensuring that its hazardous waste is managed appropriately, many in the general public feel that the nuclear industry should not continue in operation without having a trustworthy solution for the safe disposal of its radioactive waste. The operational and decommissioning of nuclear facilities and the associated environmental restoration strategy require public acceptance. The implementation of new and more precise measurement methods and techniques for waste measurement will result in more effective protection of the general population and workers against undesirable radiation exposure and it will enhance public confidence in radioactive waste management in operational and decommissioning nuclear facilities.

**List of publications**

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Project start date and duration:		01 June 2021, 36 months
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