Report to the CCRI Section II on the activity carried out at the ENEA-INMRI on radionuclide measurements in the period 2007-2009

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1. INTRODUCTION

The present report summarizes the 2007-2009 activities carried out at the National Institute for Ionising Radiation Metrology (ENEA-INMRI) in the field of interest of CCRI Section II, i.e. radionuclide measurements. The main characteristics of the national standards maintained in Italy at the ENEA-INMRI in the field of radionuclide measurements are reported in the following table.

National standards maintained at the ENEA-INMRI (Italy) in the field of radionuclide measurements

Quantity	Standard	Radionuclide	Uncertainty Range (^) (%)	Measurement Range
Activity (+)	-n. 2 $4\pi\beta$-γ coincidence counting systems	β and β-γ emitters	0.1 - 3	(1 - 20) kBq
	-n. 1 NaI(Tl) well-type sum-peak coincidence counting system	γ–γ emitters	0.5 - 3	(1 - 20) kBq
	-n. 1 NaI(Tl) well-type $4\pi\gamma$ counting system	γ emitters	0.5 - 3	(1 - 20) kBq
	-n. 1 LS (CIEMAT/NIST) counting system	β and x-ray emitters	0.6 - 3	(1 - 20) kBq
	-n. 1 Rn-in-water generator	^{222}Rn-in-water	2	$(200 - 10^4)$ Bq/dm^3
	-n. 1 Electrostatic cell	^{222}Rn-in-air	1	(1 - 15) kBq
	-n. 1 Well-type ionisation chamber*	γ emitters	0.2 - 3	$(10 - 2\ 10^4)$ kBq
	-n. 3 HPGe γ-ray spectrometers*	x and γ emitters	1 - 5	$(1 - 10^5)$ Bq
Activity concentration	-n. 1 0.1 m^3 radon chamber*	^{222}Rn-in-air	2 - 10	$(10^2 - 10^4)$ Bq/m^3
Surface emission rate	-n. 1 2π windowless gas flow proportional counter	α and β emitters	0.5 - 3	(1 - 20) s^{-1}

(^) Rounded values for standard combined uncertainties (1σ).
(*) High precision secondary standards.
(+) Issue of radioactivity standards: Standard radioactive sources are supplied in different geometries in the activity concentration range from 10^{-2} Bq g^{-1} to $2\ 10^6$ Bq g^{-1} (aqueous solutions in standard ampoule or in flask of different size) and in the activity range from 1 Bq to $2\ 10^7$ Bq (sources in Marinelli beaker, in ampoule, on paper filter and point sources).

The ENEA-INMRI programmes in the field of radionuclide metrology during the last two years have been focused on maintaining and developing the national standards for activity measurements and on the more general activities in the field of standardisation and quality-assurance in radioactivity measurements.

Extensive restructuration works in the radioactivity measurements rooms, as requested by the control authority for radiological protection, lasted about all the year. In this period, the research and calibration activity in this field was strongly reduced.

The main specific activities carried out at ENEA-INMRI in field of radionuclide metrology are summarised below.

2. DEVELOPMENT OF NATIONAL STANDARDS AND COMPARISONS

Standardisation of ^{64}Cu by 4πβ liquid scintillation efficiency-tracing method

The 4πβ Liquid Scintillation Spectrometry Method with ^{3}H-Standard Efficiency Tracing, in literature known as CIEMAT/NIST method, has been applied to measure the activity concentration of a ^{64}Cu solution. The measurements of the ^{64}Cu activity has been performed at the EC Joint Research Centre (EC-JRC) of Ispra under a scientific collaboration between the ENEA-INMRI and the Institute for Health and Consumer Production. The isotope has been produced by the Scanditronix MC40 Cyclotron of the EC-JRC and standardised at the production site. The new national standard has been used to calibrate the ENEA-INMRI portable well-type ionisation chamber (IC), used as Secondary Standard Measurement System (*SSMS*) and then easily transportable in Nuclear Medicine centres or in the other production sites to calibrate local instrumentation by a simpler comparison. A particular effort has been dedicated to identify β-impurities in the ^{64}Cu. The final data has been presented at the ICRM Conference which has been held on September 2007 in Cape Town.

3. QA NATIONAL PROGRAMME AND CALIBRATION ACTIVITY

3.a Development of a ^{64}Cu transfer standard

A new portable well-type ionisation chamber was calibrated with uncertainty lower than 2% by the ENEA-INMRI, using the newly developed ^{64}Cu primary standard. This new chamber can be used as a transfer secondary standard measurement system. It can be transported in Hospitals or in ^{64}Cu production centres where the local instrumentation can be calibrated by comparison.

3.b Development of the ^{124}I secondary standard

^{124}I is an emerging Nuclear Medicine radionuclide and some requests for calibrating well-type ionization chamber for this nuclide have been addressed to the ENEA-INMRI by radiopharmaceuticals production centres and Hospitals of our Country.
A new ^{124}I secondary standard has been developed by our Institute by using a high energy resolution HPGe detector calibrated by standardised gamma ray sources traceable to the ENEA-INMRI primary standards in view of the development of a primary standard of this nuclide.

3.c Calibration of radioactive sources

Production and delivery of calibration sources for external users has been strongly reduced for extensive restructuration works in the radioactivity measurements Laboratory.

3.d Calibration of radionuclide activity measurement instruments

The measurement instrument calibration service was strongly reduced due to the same reason explained above. Nevertheless about 20 surface contamination monitors were calibrated according to ISO standards in the 2007-2009 period by using mainly ^{241}Am, ^{90}Sr and ^{14}C sources.

3.e Calibration of ^{18}F measuring systems

A growing request for calibration of ^{18}F measuring system (radionuclide calibrators) is coming from the different production centres and the Nuclear Medicine Department in our country. The ENEA-INMRI Secondary Standard Measurement System *(SSMS)* was then used for calibrating many activity radionuclide calibrators used in different Nuclear Medicine Departments and ^{18}F[FDG] production centres of our country.

3.f Quality assurance programme for the national radioactivity surveillance network

Extensive restructuration of the ENEA radon chambers and calibration activities for national users have been carried out since 2005.

4. PARTICIPATION IN METROLOGICAL AND STANDARDISATION ORGANISATIONS

Part of the time was devoted to activity in metrological and standardisation organisations: ICRM, BIPM/CCRI-II, IEC/TC45, ISO/TC85/SC2, UNI (National Standardisation Organisation). P. De Felice has continued his office as Secretary of the International Committee of Radionuclide Metrology.

5. STAFF

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(1) Due to the shortage of personnel some technicians share their work (e.g., mechanical workshop) among the different sections of the Institute.

(2) Administrative service and technical assistance for maintaining and repair are supplied by the CR Casaccia central service. Some activities at the ENEA-INMRI in the period 2007-2009 have been carried out with the collaboration of some students.

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