

Implementation of an Intercomparison Exercise according to ISO/IEC 28218 in the Internal Dosimetry Services of Spanish Nuclear Power Plants

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1. INTRODUCTION.

- Spanish Nuclear Safety Council (CSN) organized an in vivo intercomparison exercise That was carried out by WBC IDS (CIEMAT)
- Technical requirements based on ISO/IEC 28218 "Performance Criteria for Radiobioassay".
- 2009-2010 National Intercomparison for the in vivo measurement of gamma-emitting radionuclides and radioiodine in thyroid in internal dosimetry services of Spanish Nuclear Power Plants (NPP) and mobil units of nuclear emergency (TECNATOM).



OBJECTIVE: VALIDATING QUALITY OF THE CAPABILITIES OF NPP'S INTERNAL DOSIMETRY SERVICES.

2. METHODOLOGY

Intercomparison Counting Geometries

- In vivo measurement of gamma-emitting radionuclides in total body
- In vivo measurement of radioiodine in thyroid

QUICKY WBC: Stand up geometry

DIYS WBC: Stretched geometry

Nuclear Emergency Mobil Units

Intercomparison Protocols sent by organizers to participants: Main issues

- Description of active phantoms, intercomparison schedule.
- Criteria of acceptance of parameters defined (ISO 28218).
- Objectives to test proficiency:**
 - Daily quality control prior to measurements.
 - Identification of radionuclides. Determination of accuracy.
 - Estimation of ⁴⁰K (No contaminated individuals).
 - Sensitivity of Detection Systems: Calculation of detection limit.

Technician of WBC-IDS (Ciemat) and Nuclear Safety Council (CSN) were "in situ" in each exercise to ensure compliance with protocol.

WBC Laboratory of IDS (Ciemat) Laboratory was in charge of:

- Manufacturing and validate intercomparison phantoms with sources simulating homogeneously internal contamination..
- Analysis of the results sent by participants according to ISO/IEC 28218.

Laboratories of IDS(CIEMAT) ISO/IEC 17025 accredited for testing and calibration purposes .

Participants.

Seven IDS of Spanish NPPs and nuclear emergency mobile units of TECNATOM

Facility	QUICKY WBC	DIYS WBC
NPP Almaraz	Nal (102x102x76)	Nal(205x100)
NPP Garoña	Nal (102x102x76)	Nal canberra(5x%)
NPP Ascó	Nal (102x102x76)	Nal(205x100)
NPP Vandellós II	Nal (102x102x76)	Nal(205x100)
NPP Zorita		Nal(205x100)
NPP Cofrentes	Nal (102x102x76)	Nal(205x100)
Mobile units TECNATOM	Nal (102x102x76)	4 detectors (10x10x7.5)
NPP Trillo	Nal (102x102x76)	

Intercomparison results were required by organizers two months after finishing the exercise. Anonymous code was assigned to participants.

3. MATERIALS

BOMAB Phantom simulating internal contamination in total body.

- Simulates the ICRP 89 reference man.
- Fabricated according to ANSI/HPS N13.35.
- Ten pieces of tissue-equivalent plastic were filled at the In Vitro Bioassay Laboratory (IDS-Ciemat) with an acidified distilled water solution and five gamma emitters' radionuclides certified solutions homogeneously distributed.

For testing gamma spectrometry software of participants Nuclear Safety Council and WBC IDS (CIEMAT) proposed a complex cocktail of gamma emitters.

Radionuclide	T _{1/2}	E (keV)	Ie (%)	A ₅₁ (kBq)
⁵⁷ Co	271.40 d	122.06	85.60	20
¹³⁷ Cs	30.13 y	661.65	85.00	20
⁵⁴ Mn	312.16 y	834.85	99.98	20
⁸⁸ Y	106.63 d	898.04	94.00	15
⁶⁰ Co	5.27 y	1173.24	99.90	20
⁶⁰ Co	5.27 y	1332.50	99.98	20
⁸⁸ Y	106.63 d	1836.06	99.33	15

Thyroid Neck Phantom simulating internal contamination in thyroid

- Testing proficiency of participants in determination of radioiodine in thyroid in different scenarios of measurement (low and high activity).
- Two 20 ml vials of standard liquid source of ¹³³Ba used for simulating ¹³¹I due to its short half live.

Radionuclide	T _{1/2}	E (keV)	Ie (%)
¹³¹ I	8 d	80.2	2.60
		284.3	6.10
		364.5	81.20
¹³³ Ba	10.5 y	81.0	36.00
		276.0	7.00
		356.0	62.00

5. CONCLUSIONS

- Performance criteria according to ISO/IEC 28218 were fulfilled by all the participants of the in vivo intercomparison exercise.
- Technical recommendations were proposed by both WBC laboratory of IDS (CIEMAT) and Nuclear Safety Council (CSN), based on final results analysis in order to promote improvements to ensure the quality of the measurements.
- Improvements in measurement procedures are recommended in what concerns daily quality controls and the determination of detection limits.**

4. ANALYSIS OF THE RESULTS

"Accuracy" analysis according to ISO/IEC 28218.

In vivo measurements of BOMAB phantom: QUICKY & DIYS WBC.

- Five measurements of BOMAB phantom were realized in routine conditions.
- Results were compliance with acceptance criteria of ISO 28218 parameters used (Bias relative and Repeatability) for all radionuclides and participating IDS.
- Complex multiplet between energy lines of ⁵⁴Mn and ⁸⁸Y. Good results.

In vivo measurements of radioiodine in thyroid: QUICKY & DIYS WBC.

- Five measurements of ANSI standard thyroid uptake neck phantom with 20 ml vials of ¹³³Ba simulating thyroid gland were realized in routine conditions.
- Results were in compliance with acceptance criteria of parameters ISO 28218.
- An overestimation of ¹³³Ba values was observed in most of the detection systems.

Estimation of ⁴⁰K in human body.

- Testing measurements in case of non-contaminated individuals.
- The same blank person was measured in each detection system of participants.
- An **overestimation of ⁴⁰K values** was observed in all the detection systems.
- Organizers proposed to subtract the contribution of daily environmental background to the individual measurement.

Activity (⁴⁰K) = 4780 Bq

- QUICKY. (T_C=120s)
- DIYS. (T_C=480s)

- ### Sensitivity of Detection Systems: Calculation of detection limits.
- The value of the "detection limit" indicates the ability of the service laboratory to detect a radionuclide in direct measurements of individuals.
 - The detection limit is person dependent and can be used to estimate the sensitivity of the detection systems in a specific geometry of measurement taking into account routine conditions (specially the counting time).
 - Calculation of DL by ISO/IEC 28218 is proposed by organizers to achieve harmonization in Spanish Internal Dosimetry Services.**