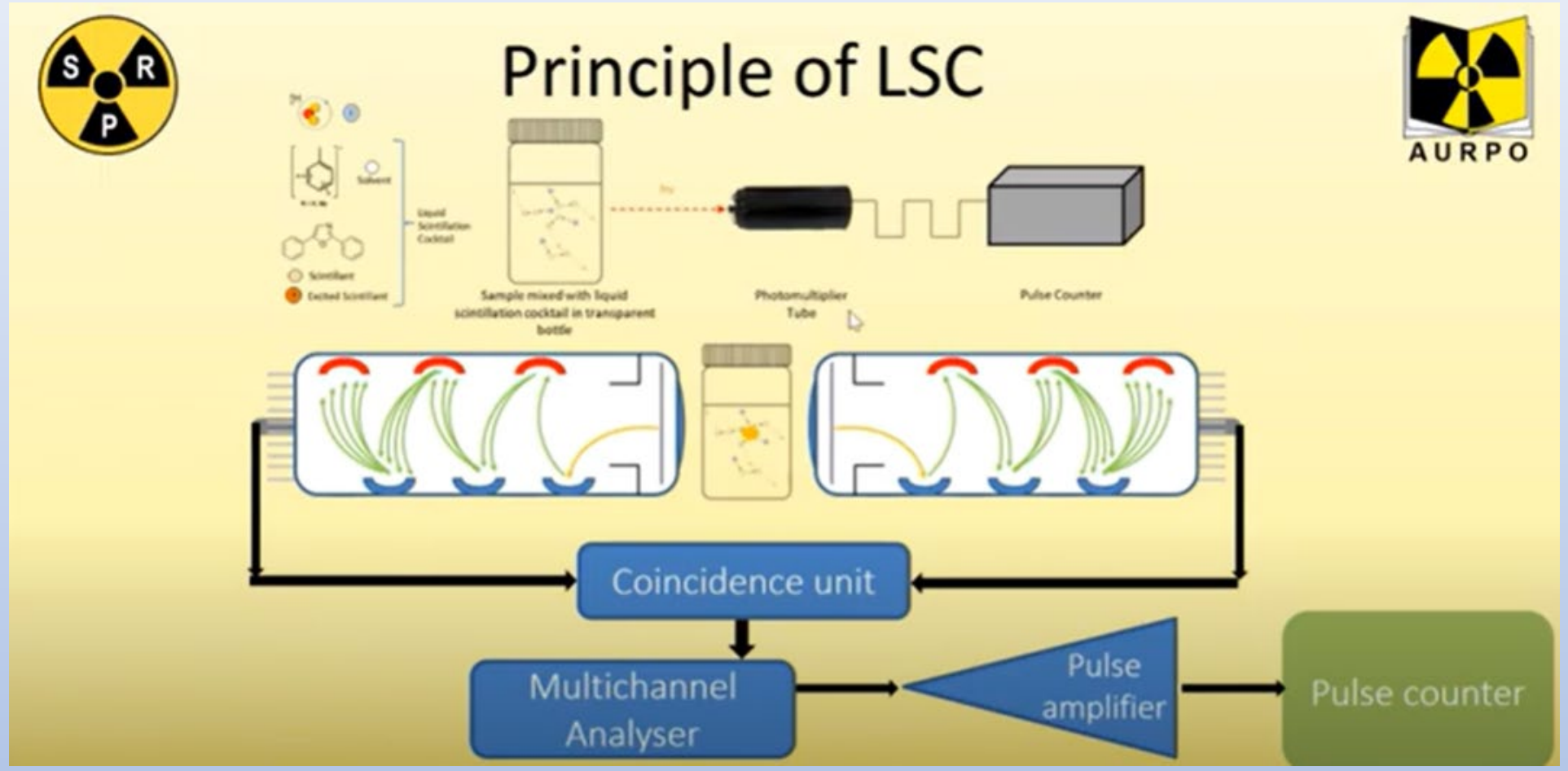
Radon in Water Analysis

Liquid Scintillation Counting


14C
3H
8KG
ALL SYSTEMS EXCEPT 2X80 AND 2X70

Coincidence Counting



LS Counter Strengths

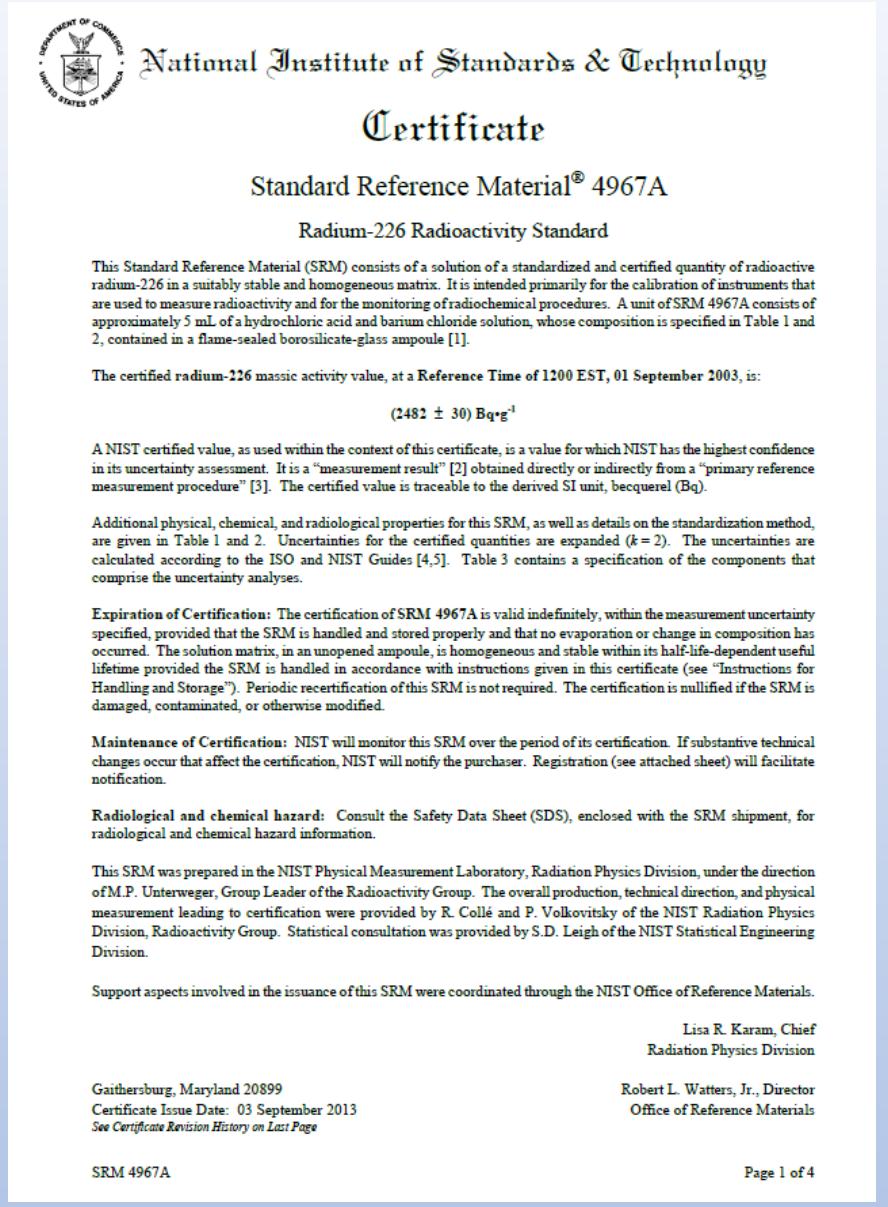
- High sensitivity, low background
- Automated sample loading
- Supports multiple counting protocols
- Daily startup checks
- C14, H3, Background

Sampling & Sample Transfer

- Accuracy relies on careful sample collection
- Care also required during sample transfer
- Scintillation fluid added to water sample
- Four-hour equilibrium period
- 30-50 minute counting times/sample

Calibration

- No “Bowser-Morner” for radon in water
- Calibration starts with a Radium-226 solution
- Diluted to create multiple standards & various activities
- 30-day ingrowth period
- NY ELAP requires 2 strengths from 2 Radium LOTS (~4,000 pCi/L & 10,000 pCi/L)
- Sealed to prevent opening



National Institute of Standards & Technology

Certificate

Standard Reference Material® 4967A

Radium-226 Radioactivity Standard

This Standard Reference Material (SRM) consists of a solution of a standardized and certified quantity of radioactive radium-226 in a suitably stable and homogeneous matrix. It is intended primarily for the calibration of instruments that are used to measure radioactivity and for the monitoring of radiochemical procedures. A unit of SRM 4967A consists of approximately 5 mL of a hydrochloric acid and barium chloride solution, whose composition is specified in Table 1 and 2, contained in a flame-sealed borosilicate-glass ampoule [1].

The certified **radium-226** massic activity value, at a **Reference Time of 1200 EST, 01 September 2003**, is:

(2482 ± 30) Bq•g^{-1}

A NIST certified value, as used within the context of this certificate, is a value for which NIST has the highest confidence in its uncertainty assessment. It is a “measurement result” [2] obtained directly or indirectly from a “primary reference measurement procedure” [3]. The certified value is traceable to the derived SI unit, becquerel (Bq).

Additional physical, chemical, and radiological properties for this SRM, as well as details on the standardization method, are given in Table 1 and 2. Uncertainties for the certified quantities are expanded ($k = 2$). The uncertainties are calculated according to the ISO and NIST Guides [4,5]. Table 3 contains a specification of the components that comprise the uncertainty analyses.

Expiration of Certification: The certification of **SRM 4967A** is valid indefinitely, within the measurement uncertainty specified, provided that the SRM is handled and stored properly and that no evaporation or change in composition has occurred. The solution matrix, in an unopened ampoule, is homogeneous and stable within its half-life-dependent useful lifetime provided the SRM is handled in accordance with instructions given in this certificate (see “Instructions for Handling and Storage”). Periodic recertification of this SRM is not required. The certification is nullified if the SRM is damaged, contaminated, or otherwise modified.

Maintenance of Certification: NIST will monitor this SRM over the period of its certification. If substantive technical changes occur that affect the certification, NIST will notify the purchaser. Registration (see attached sheet) will facilitate notification.

Radiological and chemical hazard: Consult the Safety Data Sheet (SDS), enclosed with the SRM shipment, for radiological and chemical hazard information.

This SRM was prepared in the NIST Physical Measurement Laboratory, Radiation Physics Division, under the direction of M.P. Unterweger, Group Leader of the Radioactivity Group. The overall production, technical direction, and physical measurement leading to certification were provided by R. Collé and P. Volkovitsky of the NIST Radiation Physics Division, Radioactivity Group. Statistical consultation was provided by S.D. Leigh of the NIST Statistical Engineering Division.

Support aspects involved in the issuance of this SRM were coordinated through the NIST Office of Reference Materials.

Lisa R. Karam, Chief
Radiation Physics Division

Gaithersburg, Maryland 20899
Certificate Issue Date: 03 September 2013
See Certificate Revision History on Last Page

Robert L. Watters, Jr., Director
Office of Reference Materials

SRM 4967A

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Lab Intercomparisons

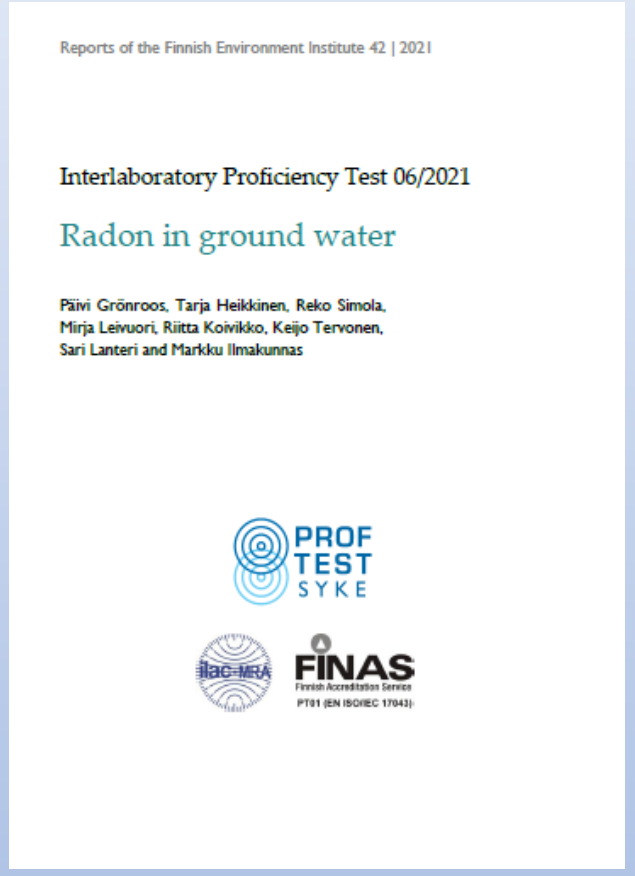
- Dr Kitto's radium disks were the only intercomparison source for years
- Re-usable by the lab after the intercomparions
- Lasted several years but eventually began to degrade
- New program needed!

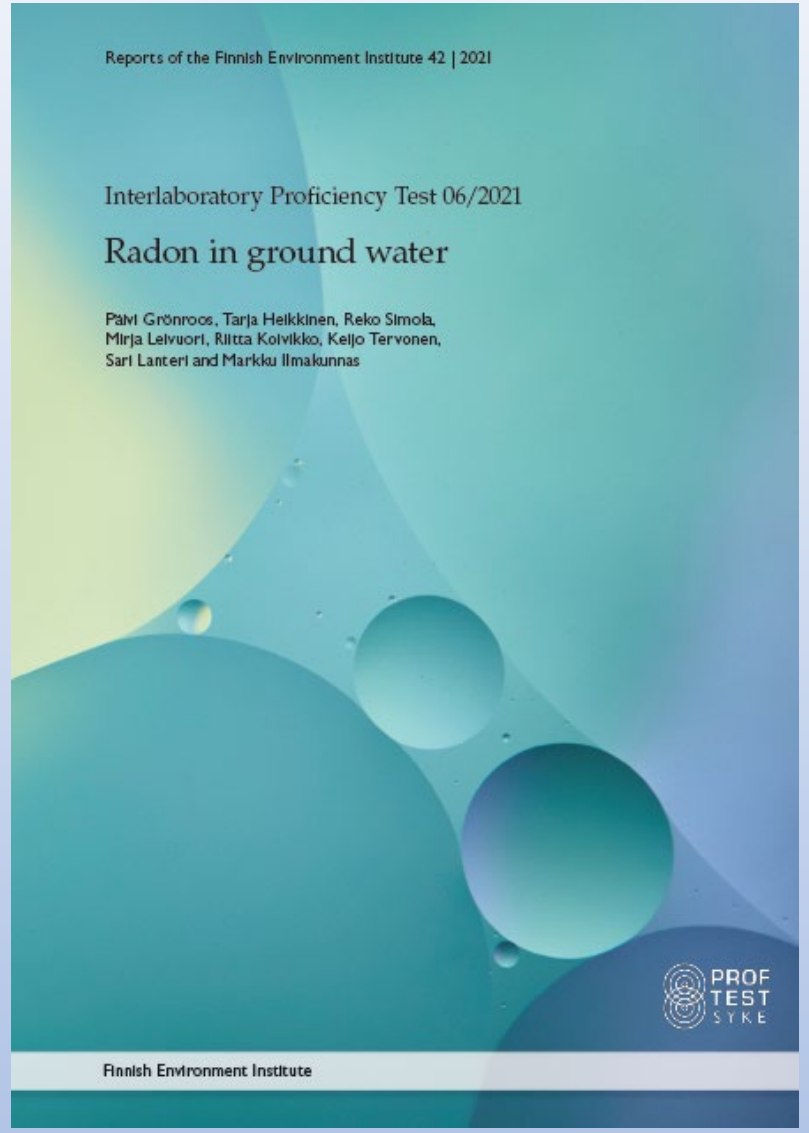
Intercomparison Ideas

- Swapping Ra-226 standards?
  - Regulatory issues – Radium often requires a license
  - Clean-up & contamination issues if broken
- Use a radon source to spike water?
  - Bubbling air from the radon source might cause too much agitation
  - Source strength probably too low
- Use a natural source (rock, gravel, sand) in a sealed container?
- Reliable well with high radon concentrations?
  - Labs often give different results, so determining the “known” value might be challenging

Proficiency Program

- Finnish Environmental Institute





Appendix I. Participants in the proficiency test

Country	Participant
Belgium	Institute for radioelement, LMR department
Finland	Eurofins Environment Testing Finland Oy, Lahti
	KVVY Tutkimus Oy, Tampere
	Kymen Ympäristölaboratorio Oy
	Lounais-Suomen vesi- ja ympäristötutkimus Oy, Turku
	LUVYLab Oy Ab
	MetropoliLab Oy
	Savo-Karjalan Ympäristötutkimus Oy, Kuopio
	ScanLab Oy
	STUK, Ympäristön säteilyvalvonta, Mittaus ja Analyysit (MIT)
	Vita Laboratoriot Oy
	ÅMHM laboratoriet, Jomala, Åland
France	Eurofins Eichrom Radioactivite
	Laboratoire CARSO LSEHL
	PearL, Limoges Cedex
Italy	ARPAT
	Environmental Protection Agency of Friuli Venezia Giulia (Arpa FVG)
	Protex Italia Srl
Norway	The Norwegian Radiation Protection Authority
Spain	Unitat de Radioquimica Ambiental i Sanitaria (URAIS)
Sweden	Eurofins Water Testing Sweden AB
	Uppsala Vatten och Avfall AB
United Kingdom	Scottish Water
	South West Water Ltd
United States	Accustar Labs

Reports of the Finnish Environment Institute 27 | 2023

Proficiency Test 06/2023

Radon measurements in ground water

Päivi Grönroos, Mirja Leivuori, Tarja Heikkinen,
Keijo Tervonen, Sari Lanteri, and Markku Ilmakunnas

PROF TEST SYKE

FINAS Finnish Accreditation Service PT01 (EN ISO/IEC 17043)

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	KVVY Tutkimus Oy, Tampere
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	STUK, Ympäristön säteilyvalvonta, Mittaus ja Analyysit (MIT)
	ÅMHM laboratoriet, Jomala, Åland
France	Eurofins Eichrom Radioactivite
	Laboratoire Phytocontrol
	PearL, Limoges Cedex
Italy	A.R.P.A. Umbria
	Acque Veronesi
	ARPAT
	CAP Holding S.p.a.
Norway	The Norwegian Radiation and Nuclear Safety Authority
Spain	Instituto Universitario de Seguridad Industrial, Radiofísica y Mediambiental (ISIRYM)
	Unitat de Radioquimica Ambiental i Sanitaria (URAIS)
	Universitat Politècnica de València, Laboratorio de Radiactividad Ambiental
Sweden	Eurofins Water Testing Sweden AB
	SGS Analytics Sweden AB
	Uppsala Vatten och Avfall AB
United Kingdom	Scottish Water
	South West Water Ltd
United States	Accustar Labs

Participant 20

Measurand	Unit	Sample	-3 0 3	z score	Assigned value	2×s_{pt} %	Participant's result	Md	Mean	s	s %	n_{lab}
^{222}Rn	Bq/l	GRn1		-1.61	59.5	20	49.9	59.7	59.5	6.5	10.9	31
	Bq/l	GRn2		-0.21	5835	20	5710	5840	5834	535	9.2	33

Participant 21

Measurand	Unit	Sample	-3 0 3	z score	Assigned value	2×s_{pt} %	Participant's result	Md	Mean	s	s %	n_{lab}
^{222}Rn	Bq/l	GRn1		1.50	59.5	20	68.4	59.7	59.5	6.5	10.9	31
	Bq/l	GRn2		1.54	5835	20	6732	5840	5834	535	9.2	33

Participant 22

Measurand	Unit	Sample	-3 0 3	z score	Assigned value	2×s_{pt} %	Participant's result	Md	Mean	s	s %	n_{lab}
^{222}Rn	Bq/l	GRn1		-0.25	59.5	20	58.0	59.7	59.5	6.5	10.9	31
	Bq/l	GRn2		0.45	5835	20	6100	5840	5834	535	9.2	33

Participant 23

Measurand	Unit	Sample	-3 0 3	z score	Assigned value	2×s_{pt} %	Participant's result	Md	Mean	s	s %	n_{lab}
^{222}Rn	Bq/l	GRn1		0.59	59.5	20	63.0	59.7	59.5	6.5	10.9	31
	Bq/l	GRn2		0.97	5835	20	6400	5840	5834	535	9.2	33

Participant 24

Measurand	Unit	Sample	-3 0 3	z score	Assigned value	2×s_{pt} %	Participant's result	Md	Mean	s	s %	n_{lab}
^{222}Rn	Bq/l	GRn1		0.25	59.5	20	61.0	59.7	59.5	6.5	10.9	31
	Bq/l	GRn2		0.41	5835	20	6073	5840	5834	535	9.2	33

Participant 25

Measurand	Unit	Sample	-3 0 3	z score	Assigned value	2×s_{pt} %	Participant's result	Md	Mean	s	s %	n_{lab}
^{222}Rn	Bq/l	GRn1		1.28	59.5	20	67.1	59.7	59.5	6.5	10.9	31
	Bq/l	GRn2		1.11	5835	20	6480	5840	5834	535	9.2	33

Participant 26

Measurand	Unit	Sample	-3 0 3	z score	Assigned value	2×s_{pt} %	Participant's result	Md	Mean	s	s %	n_{lab}
^{222}Rn	Bq/l	GRn1		0.76	59.5	20	64.0	59.7	59.5	6.5	10.9	31
	Bq/l	GRn2		0.61	5835	20	6190	5840	5834	535	9.2	33

Participant 27

Measurand	Unit	Sample	-3 0 3	z score	Assigned value	2×s_{pt} %	Participant's result	Md	Mean	s	s %	n_{lab}
^{222}Rn	Bq/l	GRn1		0.10	59.5	20	60.1	59.7	59.5	6.5	10.9	31
	Bq/l	GRn2		0.63	5835	20	6200	5840	5834	535	9.2	33

Participant 28

Measurand	Unit	Sample	-3 0 3	z score	Assigned value	2×s_{pt} %	Participant's result	Md	Mean	s	s %	n_{lab}
^{222}Rn	Bq/l	GRn1		0.03	59.5	20	59.7	59.7	59.5	6.5	10.9	31
	Bq/l	GRn2		1.31	5835	20	6602	5840	5834	535	9.2	33

Participant 29

Measurand	Unit	Sample	-3 0 3	z score	Assigned value	2×s_{pt} %	Participant's result	Md	Mean	s	s %	n_{lab}
^{222}Rn	Bq/l	GRn1		-1.65	59.5	20	49.7	59.7	59.5	6.5	10.9	31
	Bq/l	GRn2		-1.62	5835	20	4892	5840	5834	535	9.2	33

Participant 24

Measurand	Unit	Sample	-3 0 3	z score	Assigned value	2×s_{pt} %	Participant's result	Md	Mean	s	s %	n_{lab}
^{222}Rn	Bq/l	GRn1		0.25	59.5	20	61.0	59.7	59.5	6.5	10.9	31
	Bq/l	GRn2		0.41	5835	20	6073	5840	5834	535	9.2	33