SnT 2019
CTBT: SCIENCE AND TECHNOLOGY CONFERENCE

CTBTO PREPARATORY COMMISSION
COMPREHENSIVE NUCLEAR-TEST-BAN TREATY ORGANIZATION

Status and results of Xenon Proficiency Test Exercises

Herbert Gohla, Naoko Inoue, Nikolaus Hermanspahn, Romano Plenteda

herbert.gohla@ctbto.org

T3.2-P9

Objective

Establishment of Xenon Proficiency Test Exercises (PTEs).

Introduction

One key element of the quality assurance/control (QA/QC) program for IMS Noble Gas systems of the Radionuclide network will be based on sample re-analyses at International Monitoring System laboratories. Station and Radionuclide Laboratory results of measurements of Xenon activity concentrations and isotope ratios will be compared since these parameters are independent of gas losses. To ensure the credibility of IMS Laboratories as providers of noble gas analysis results, the Laboratories require certification in performing analysis of noble gas samples, as well as their regular participation in a QA/QC program. Regular Xenon PTEs are a key part of the laboratory QA/QC program, and these exercises support the PTS review of Lab capabilities and compliance. Currently six IMS radionuclide laboratories have implemented noble gas measurement capabilities (using in-house developments and commercially available equipment) for the four CTBT-relevant Xenon isotopes (^{131m}Xe, ^{133}Xe, ^{133m}Xeand ^{135}Xe), for performing on-request reanalysis of NG samples from the certified IMS NG stations. Four of these IMS radionuclide laboratories have been certified for noble gas sample analysis.

Informal Xenon Proficiency Test Exercises

Laboratory inter-comparison exercises have been carried out between 2008 and 2013. Since 2013, xenon activity concentration standards, although not traceable to the International Standards, have been made available by two providers: Seibersdorf Laboratories and Idaho National Laboratory. To evaluate the quality of the laboratories results a performance matrix (Fig 1) was defined and reviewed together with a grading scheme (Fig 2) in 2017. This poster discusses the informal PTE results based on the last grading scheme. In addition to 6 IMS laboratories, 4 non-IMS laboratories have been evaluated to build confidence in the evaluation process.

	Metric	Method	Acceptance Limit	Comments
1	**Accuracy**	**zeta test**	**< 3**	**Required**
2	**Estimate of bias**	**% Difference test**	**< 20%**	**Required**
3	**Correct identification of major nuclides**	**False negative test**	**No false negative**	**Required**
4	**Correct identification of nuclides**	**False positive (FP) test (memory effect)**	**No false positive**	**Required**
5	Precision	Relative uncertainty ratio	No outlier	Indicator
6	QC Sample transport, processing	Xe volume		Observation

Figure 1 - Xe PTE Performance Matrix

Radioxenon isotopic ratios are important for supporting the discrimination among possible sources. Therefore the current grading scheme for Xe-PTE includes the evaluation of these ratios (Fig 2).

Grade	Tests passed
A	Passing all 4 required tests (false negative, false positive, %difference test & zeta test for 100% of major nuclides/ratios) **and** the uncertainty ratio test
A-	Passing all 4 required tests (%difference test & zeta test for **100%** of major nuclides/ratios), **but not** the uncertainty ratio test
	Passing all 4 required tests (%difference test & zeta test for ≥ **75%** of major nuclides/ratios), **and** the uncertainty ratio test
B	Passing all 4 required tests (%difference test & zeta test for ≥ **75%** of major nuclides/ratios), **failing** the uncertainty ratio test
B	Passing three of the 4 required tests (%difference test & zeta test for ≥ 75% of major nuclides/ratios), but not failing the false negative test
C	Passing either %difference test or zeta test for ≥ 75% of major nuclides/ratios **but** failing either false positive test or **1** false negative test
F	Meeting none of the above mentioned conditions and/or more than 1 false negative and/or 1 false negative, if the only nuclide in a single sample

Figure 2 - Xe PTE Grading scheme

Considering the relatively short half-lives of the CTBT-relevant Xenon isotopes (ranging from 9.1 h - 11.9 d), ensuring the same fixed measurement start time for all laboratories is important to provide for similar measurement conditions among the labs. However the maximum waiting time for sample arrival before start of the measurement is 8 days.

Results:

During 2017-2018 four (informal) Xe-PTEs have been conducted. Generally the performance of the IMS participating laboratories has been very good in meeting the requirements of *% difference test* in 94% of the cases and the *zeta test* in 98% of the cases. All the IMS laboratories have also met the false positive as well as false negative tests. Figure 3-5 show *%difference test* results from these Xe-PTEs.

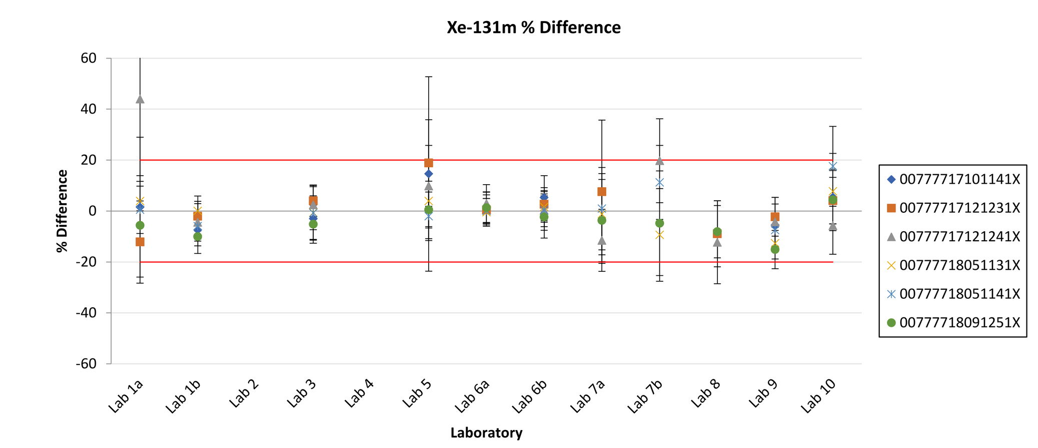

Figure 3 – Xe-131m %difference (6 samples)

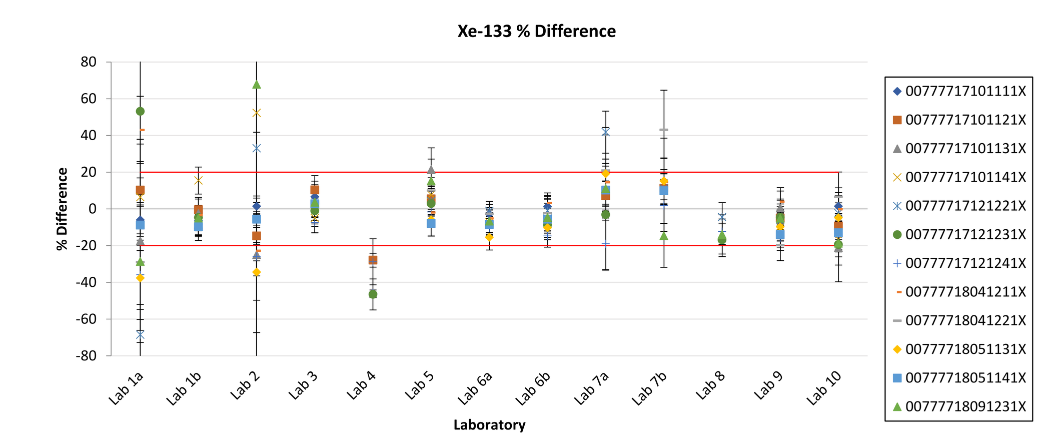

Figure 4 – Xe-133 %difference (12 samples)

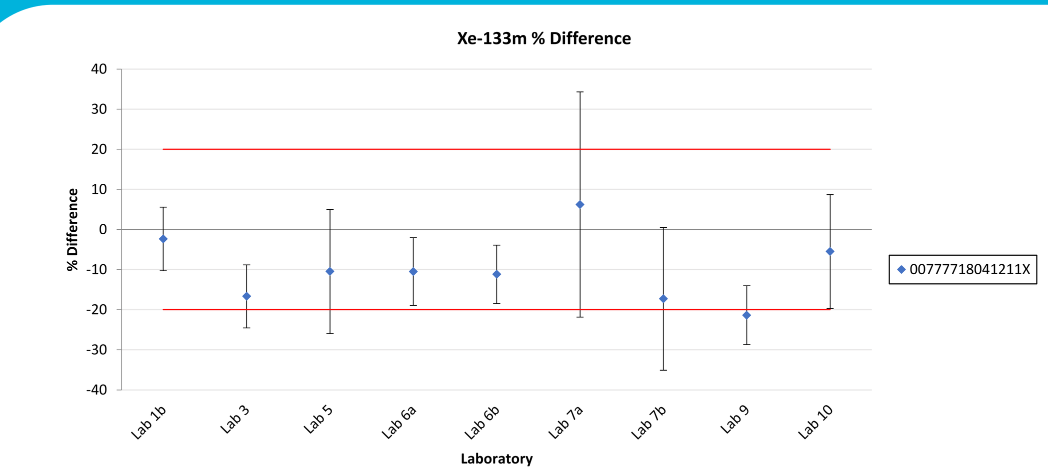

Figure 5 – Xe-133m %difference (1 sample)

Informal Xe PTEs -Laboratory Grading

Table 1 shows provisional grading results of laboratories when applying the proposed performance matrix and grading scheme.

Laboratory	PTE #1/17	PTE #2/17	PTE#1/18	PTE #2/18
	NON-IMS Laboratories			
Lab 1a	A-	B	C	B
Lab 1b	A-	A	A	B
Lab 2	C	F	F	F
Lab 3	A	A	A-	B
Lab 4	F	F	-	-
	IMS Laboratories			
Lab 5	A-	A	A	A
Lab 6a	A	A-	A	A
Lab 6b	A	A	A	A
Lab 7a	A	A-	A-	A
Lab 7b	A	A	B	A
Lab 8	-	A	-	A
Lab 9	A	A	A-	A
Lab 10	A	A	A-	A

Table 1: Provisional Grading 2017/18 PTEs

Conclusions and outlook

- The proposed Xe-PTE scheme in principle works well
- It is a challenge to use ^{135}Xe for the PTEs due to its short half-life when applying current measurement start rule
- If agreed, move on with formalization of Xe-PTE starting in 2020
- Formal Xe-PTE to be held once a year

Acknowledgements
The authors wish to thank ATL03, Seibersdorf Laboratories, Austria, CAL05, Radiation Protection Bureau, Health Canada, Ottawa, Canada, CNL06, Beijing Radionuclide Laboratory, China, FRL08, Commissariat a l'Energie Atomique, France, GBL15, Atomic Weapons Establishment, United Kingdom, USL16, Pacific Northwest National Laboratory, United Stated of America, BfS, Bundesamt für Strahlenschutz, Freiburg, Germany, FOI, Swedish Defence Research Agency, Stockholm, Sweden, ENEA, Italian National Agency for New Technologies, Bologna, Italy, Department of Energy and Physics, Amirkabir University of Technology, Tehran, Iran for the participation in the informal Xe PTEs.