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CTBT: SCIENCE AND TECHNOLOGY CONFERENCE
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Xenon International Acceptance Testing

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Pacific Northwest NATIONAL LABORATORY

INTRODUCTION

Xenon International is an automated radioxenon monitoring system that was designed to perform analysis of ultra-trace quantities of xenon gas to detect evidence of nuclear explosions.

METHODS/DATA

The system collects, separates, purifies, and quantifies radioxenon isotopes in compliance with stringent national and international requirements, providing a state-of-the-art tool for international security monitoring.

START

RESULTS

Xenon International was tested by the Provisional Technical Secretariat (PTS) for 1 year in a technical acceptance process; 6 months at the manufacturer Teledyne Brown Engineering and 6 months at RN33 in Shauinsland Germany

CONCLUSION

The Xenon International fulfills the certification requirements for a noble gas monitoring system set in CTBT/PTS/INF.921/Rev.3

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Cleared for Release

P3.2-843

PNNL-SA-186189

Xenon International Design Goals and Specifications

Increase sensitivity

- 6-hour collection, 4 samples per day, continuous sampling 24/7, 100% duty cycle
- Increased flow rate 100 L/min (stp; 0°C, 760 torr)
- MDCs: ^{133}Xe: 0.15 mBq/m3,^{135}Xe: 0.5 mBq/m3, ^{131m}Xe: 0.15 mBq/m3, ^{133m}Xe: 0.15 mBq/m3

Improve reliability and uptime

- PNNL/TBE software and hardware control
- Included manufacturer in design phase
- 2-years of testing during development
- Demonstrated combined uptime 97.8%

Reduce/eliminate consumables

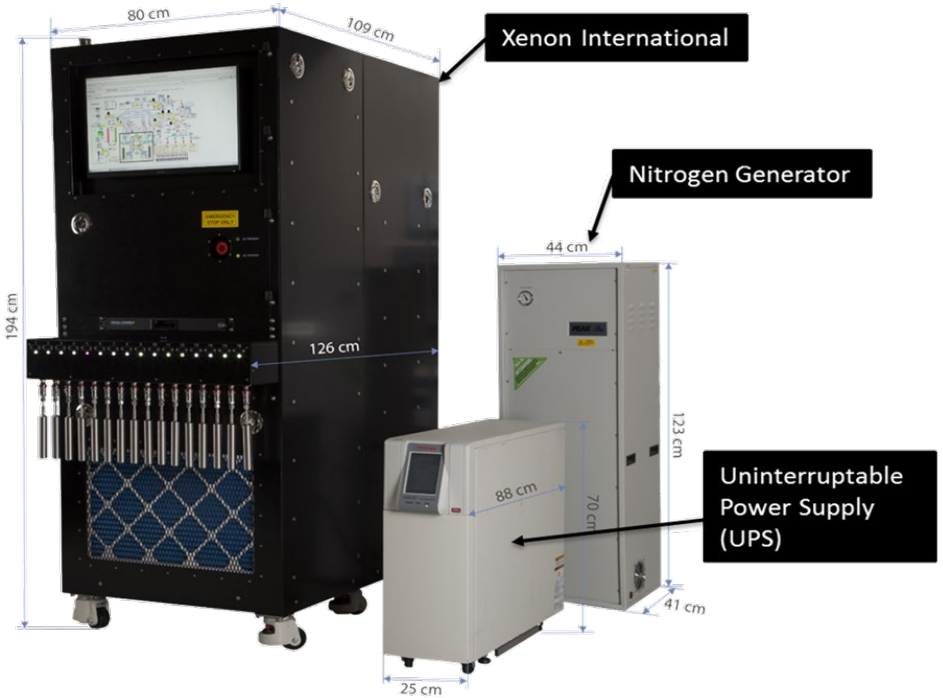
- Nitrogen carrier gas (nitrogen generator on-site)

Reduce weight and size of the system over currently deployed systems

- 1240 kg, 80 cm X 109 cm X 194 cm

Reduce power and heat load

- 208 VAC (160-275 volt), 50/60 Hz, 30-amp circuit, 4kW (3.5 kW for Xenon International without nitrogen generator)



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Testing for Acceptance as an IMS System

- Phase 1: (Developer site test) Six-month testing period from 18 April 2020 to 18 October 2020 at the TBE facility in Knoxville, Tennessee, United States of America
- Phase 2: (Off-site test) was a six-month period taking place from 14 July 2021 to 21 January 2022 at RN33, Schauinsland, Germany run by Bundesamt für Strahlenschutz (BfS)
- In both phases the system was operating in automatic mode, supervised by independent operators (TBE and BfS)
- Data (spectra, SOH information and alerts) were transmitted in real time to the PTS, where they were processed and analyzed
- Spike tests were carried out during each phase (Phase 1 and Phase 2) to verify system parameters (e.g. cross contamination, calibration parameters), and to compare measurement results with certified laboratory re-analysis

The operational performance of the system was monitored and evaluated for both Phase 1 and Phase 2. The performance of the sampling and gas processing system is described using the sampled air volume, airflow, and stable xenon volume per sample. The performance metrics of the nuclear detection system include the detection sensitivity (MDC for ^{133}Xe), the calibration validation report, and the spectral stability. Correct operational timing was monitored through the requirements for collection time, measurement time and time before reporting.

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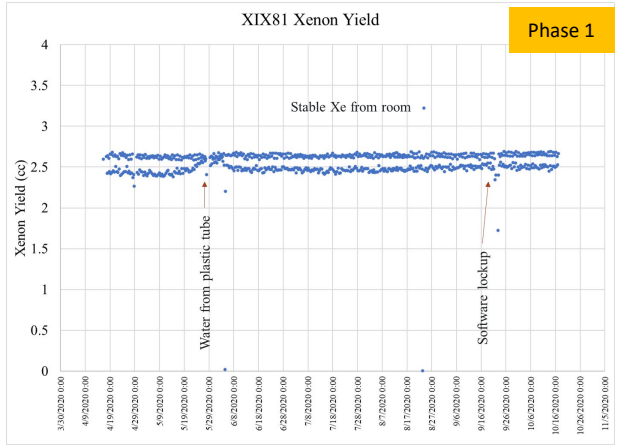
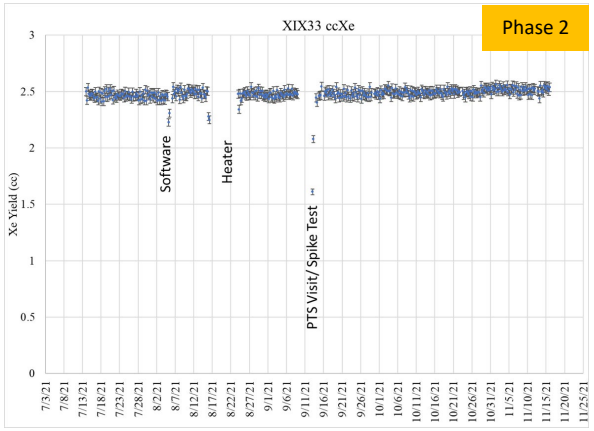
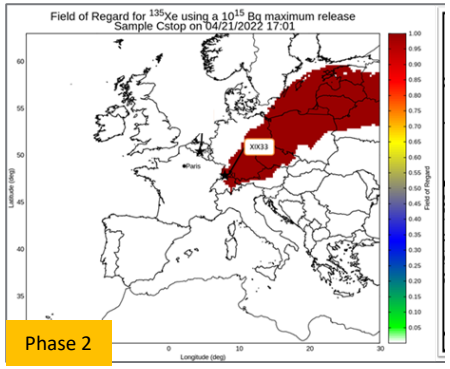
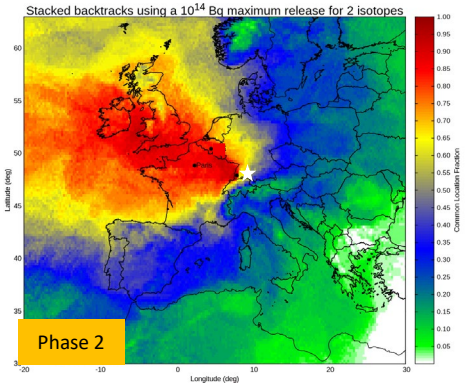
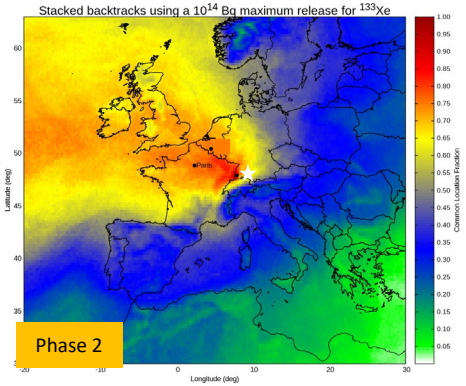
Xenon International Data during Testing



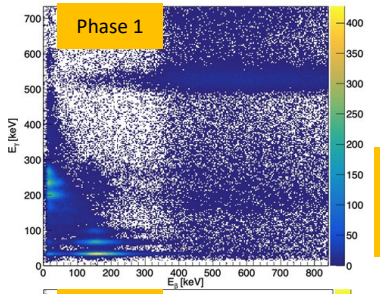


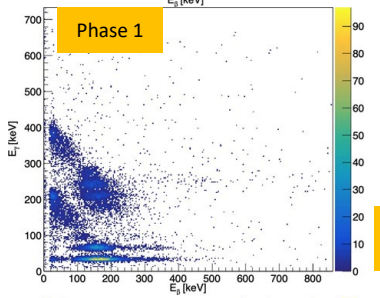


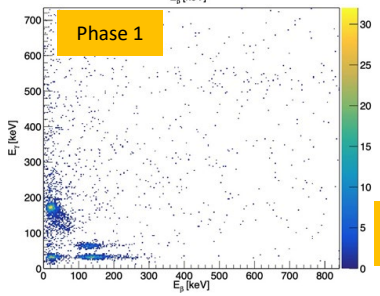


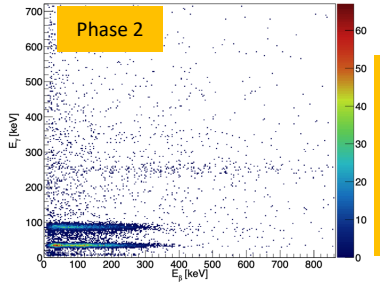


Sample info	Xenon Yield (cc)	cc Xe +/-	Xe-133m (mBq/m³)	Xe-133 (mBq/m³)	Xe-135 (mBq/m³)	Xe-131m (mBq/m³)	133m	133	135	131m	Number of Isotopes
XIX33_000-2022/04/21-20:43:59	2.413	0.036	0.214	2.799	0.047	0.245	1	1	0	1	3
XIX33_001-2022/04/22-02:43:56	2.418	0.036	0.908	37.906	0.307	-0.223	1	1	1	0	3
XIX33_002-2022/04/22-08:43:54	2.428	0.036	0.152	8.840	0.049	-0.005	0	1	0	0	1
XIX33_003-2022/04/22-14:43:55	2.471	0.037	0.093	11.310	0.013	-0.113	0	1	0	0	1
XIX33_000-2022/04/22-20:43:53	2.393	0.036	0.631	14.173	-0.118	0.436	1	1	0	1	3









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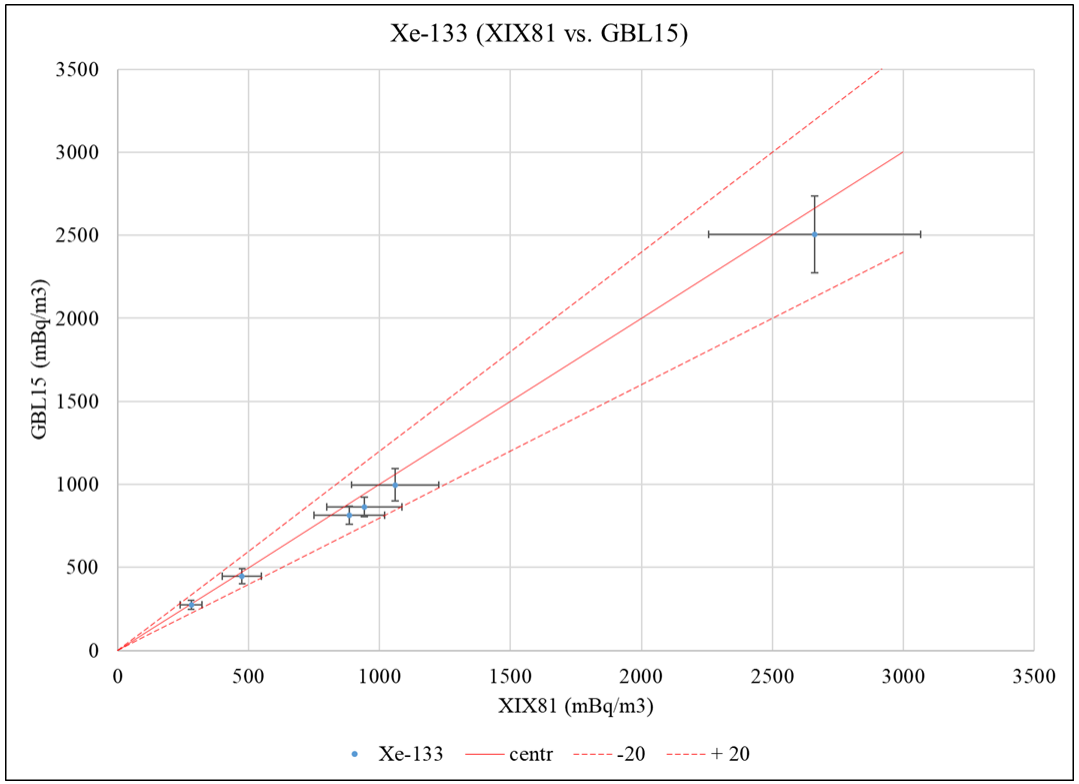
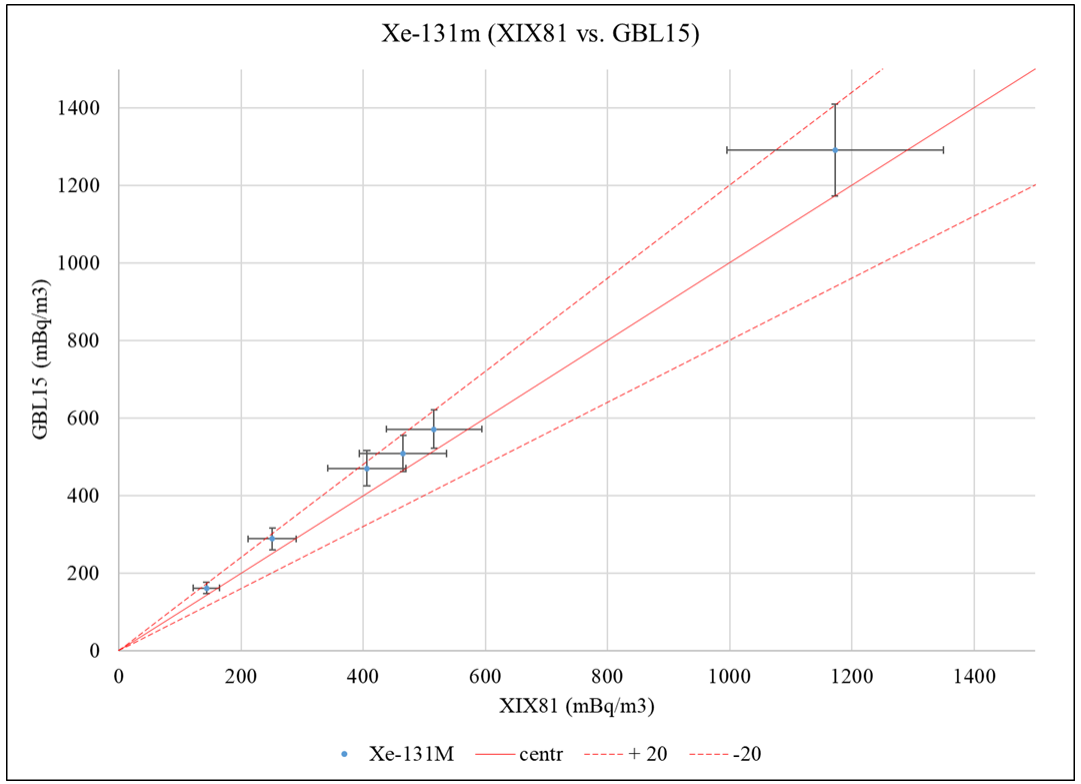
Xenon International Phase 1 Spike Tests

XIX81 Xenon International archive bottles sent to UK IMS laboratory (GBL15) for analysis of acceptance test performance samples during Phase 1 testing



Comparison of ^{133}Xe results from XIX81 and GBL15



Comparison of ^{131m}Xe results from XIX81 and GBL15

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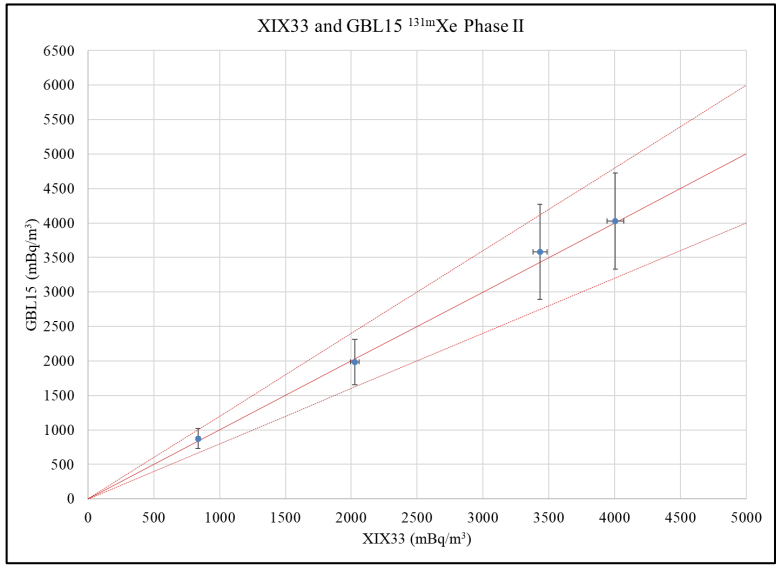
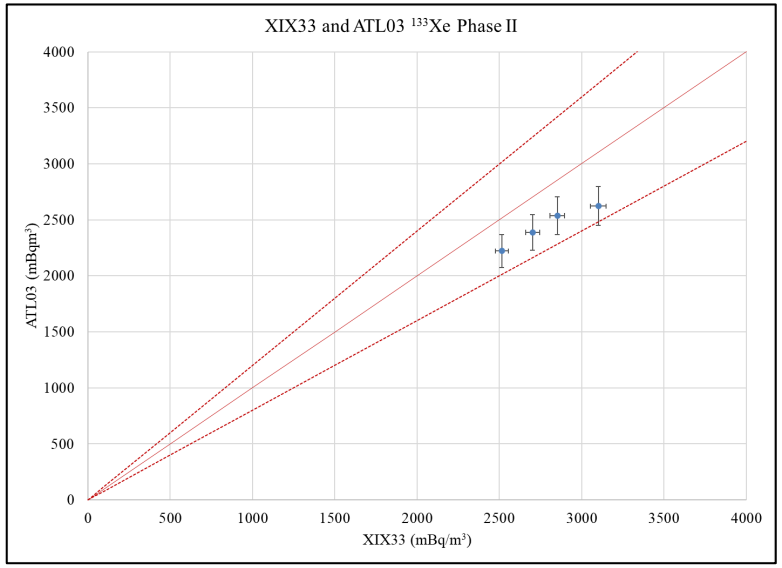
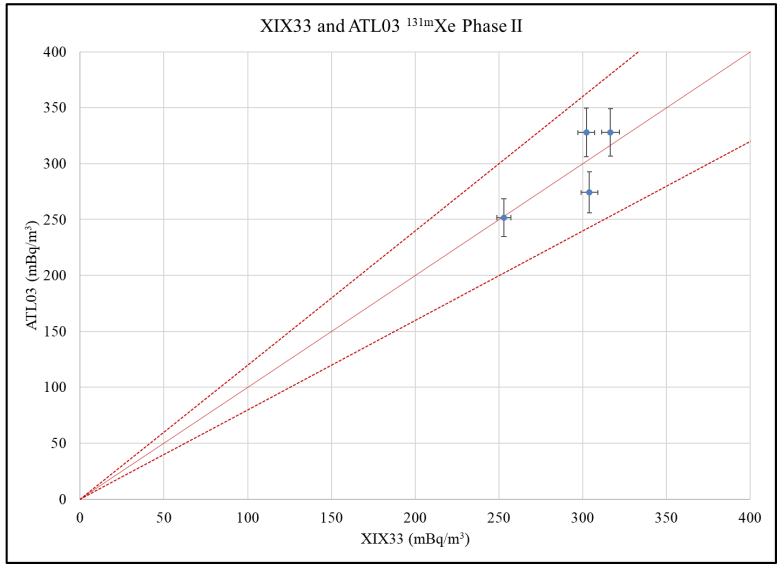
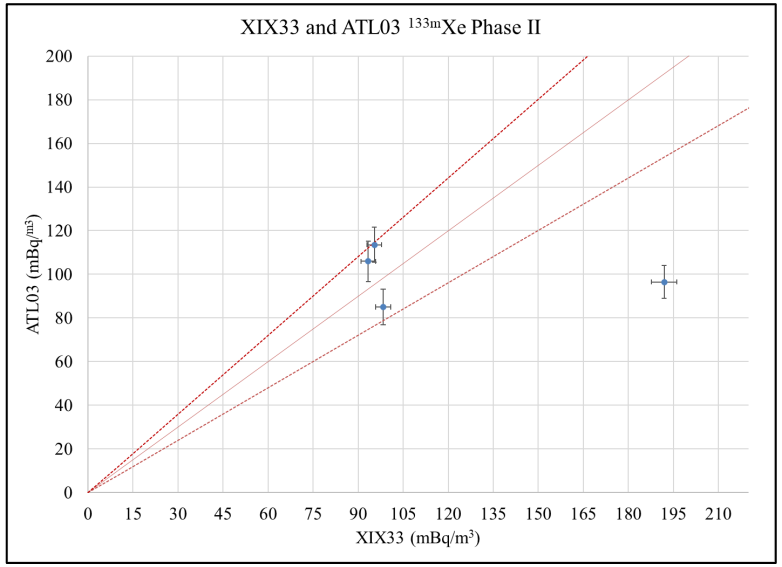
Xenon International Phase 2 Spike Tests

XIX33 Xenon International archive bottles sent to UK IMS laboratory (GBL15), and Austria (ATL) for analysis of acceptance test performance samples during Phase 2 testing









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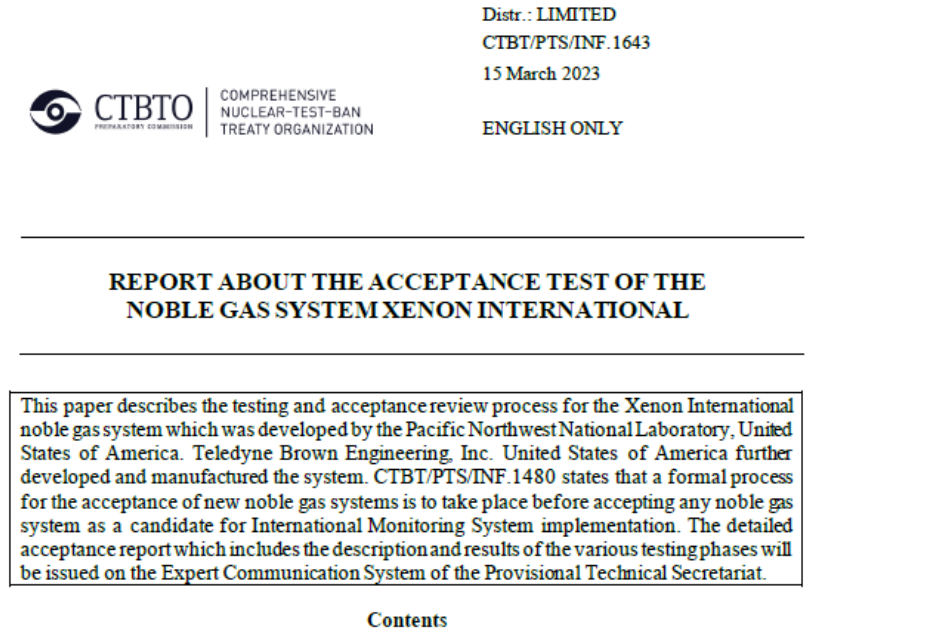
Successful Testing

The Xenon International fulfills the certification requirements for a noble gas monitoring system set in CTBT/PTS/INF.921/Rev.3

During Phase 1 testing, the Xenon International observed for the first time ever in a field system radioxenon activation products.

Data Availability Rates (must have 95%)
Phase 1: 98.36%
Phase 2: 95.6%
Total: 96.93%



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REPORT ABOUT THE ACCEPTANCE TEST OF THE NOBLE GAS SYSTEM XENON INTERNATIONAL

This paper describes the testing and acceptance review process for the Xenon International noble gas system which was developed by the Pacific Northwest National Laboratory, United States of America. Teledyne Brown Engineering, Inc. United States of America further developed and manufactured the system. CTBT/PTS/INF.1480 states that a formal process for the acceptance of new noble gas systems is to take place before accepting any noble gas system as a candidate for International Monitoring System implementation. The detailed acceptance report which includes the description and results of the various testing phases will be issued on the Expert Communication System of the Provisional Technical Secretariat.

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2019 R&D 100 WINNER

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