THE EZEIZA MIPF STAX

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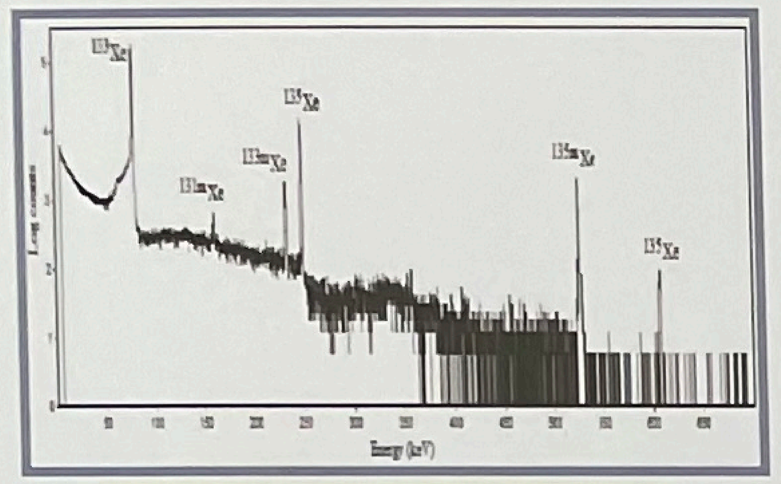
ABSTRACT

The STAX project is an experiment focused on the development of a worldwide medical isotope production facility (MIPF) stack detector network to help improve discrimination between industrial activities and nuclear explosions.

A STAX equipment manufactured by INVAP has been installed at CNEA's Radioisotope Manufacturing Plant in Ezeiza, Argentina and has been operating fault-free for more than 24 months, up to date.

This poster presents the compliance of the equipment with STAX project requirement specifications, following a sequence that starts with the reading of a detector and ends with the determination of the emission in Bq per hour of each of the radionuclides released to the environment through the stack, focusing on ^{133}Xe, ^{135}Xe, ^{133m}Xe and ^{131m}Xe.

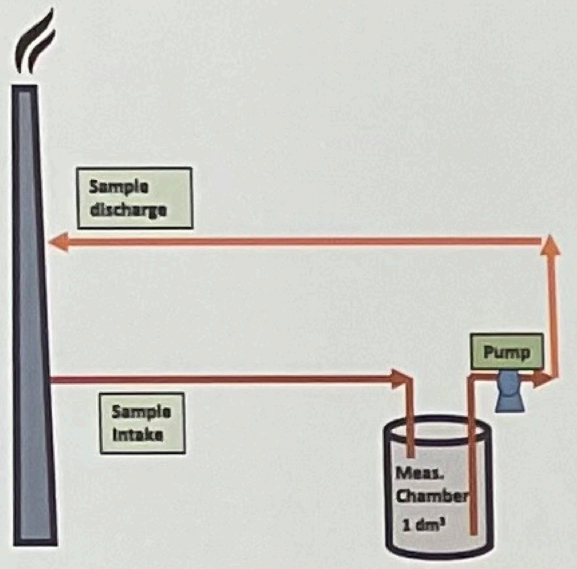
Some Facilities and Process considerations related to measurements are also analysed.



Dead time%	KCPS	Xe^{133} bq/m³	Xe^{135} bq/m³
25	48	2,31E10	7,80E9
47	120	6,03E10	1,96E10
68	200	1,00E11	2,31E10

Detection System configuration/performance

^{133}Ba and ^{152}Eu gas – like radioactive sources



Activity concentration inside the chamber shall be the same as through the stack

Measurement chamber design defines equipment size

Sample flow inside the measurement chamber is accomplished via a Sampling Pump .
Air samples inside the chamber are renewed 60 times per minute approximately.

NOTE: In case of pump stops, air convection enables to keep spectra measurement by an efficient separation of sample Intake and Discharge to the stack. In this case, chamber volume renovations are about 20 times per minute, approximately

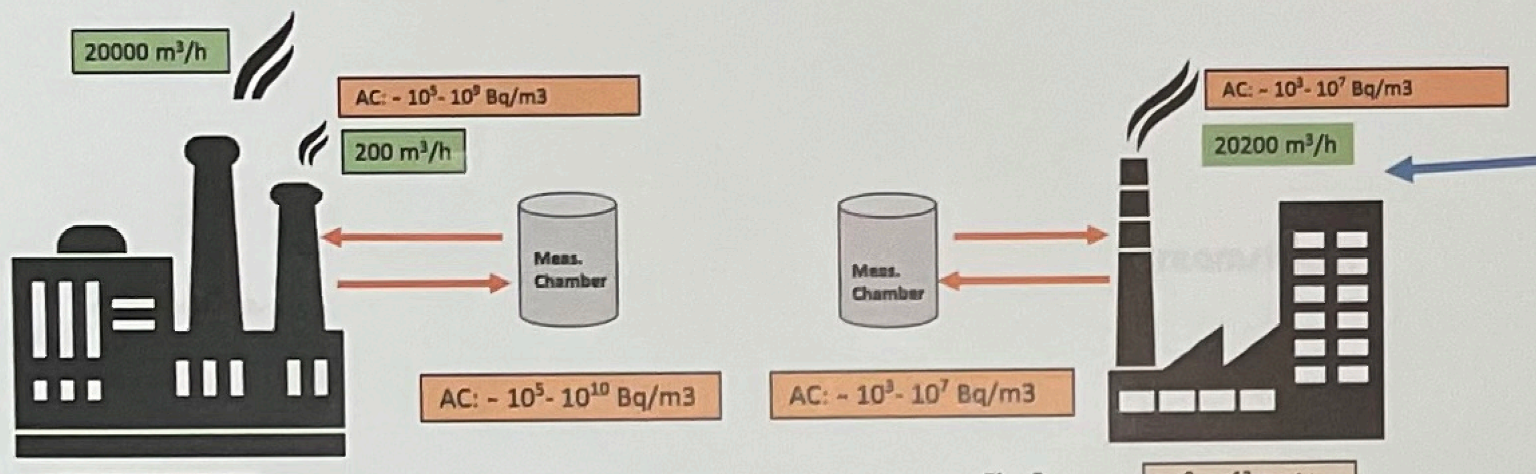


Fig. 1 Fig. 2

MIPF current ventilation system:

- Integrated by 2 sub-systems: **Hot Cells and Locals ventilation systems**, respectively.

Locals: Removes and renew the air in all places at the facility, except Hot Cells.

Typical Flow Rate is tens of thousands of m3. No radioisotopes shall be detected on this stream.

Hot Cells: Removes and renew the air at the production hot cells.

Typical Flow Rate is cents of m3. Radioisotopes can be found inside this stream.

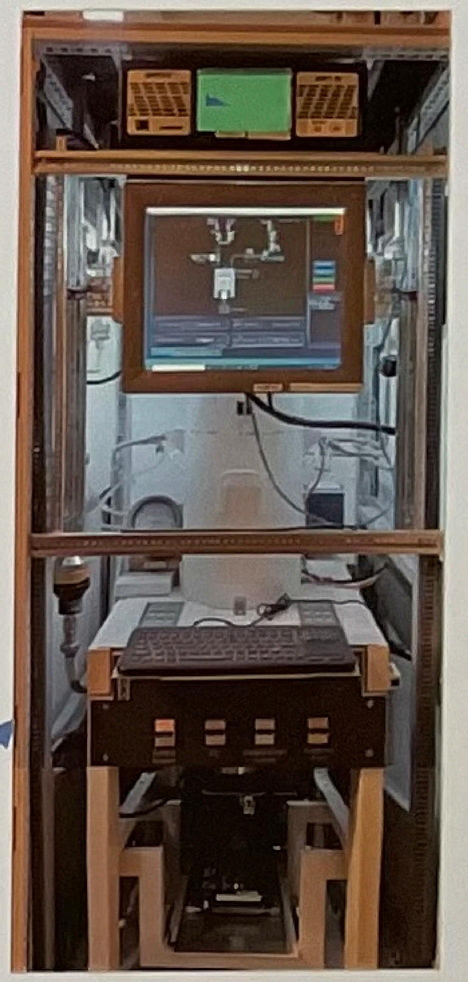
Activity concentration ranges of effluent releases inside the measurement chamber depends on facilities with 1 or 2 chimneys.

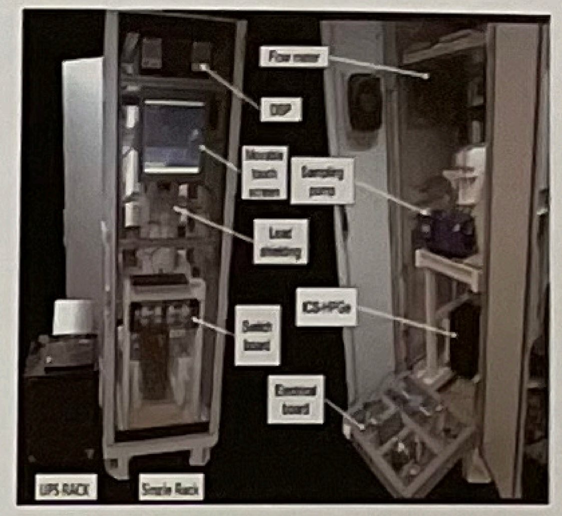
Some facilities do have independent chimneys for both subsystems (Fig. 1), while others do use a single chimney for all the releases (Fig.2) .

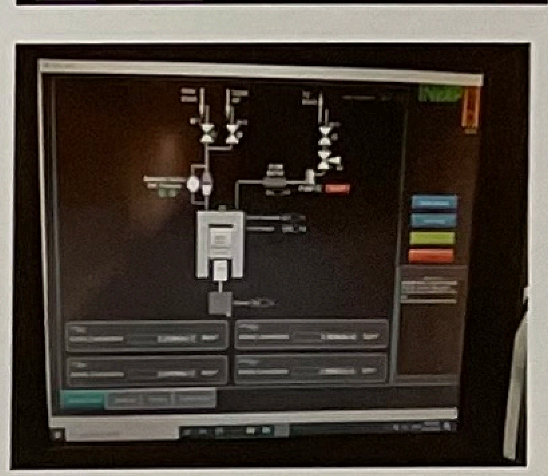
Those different configurations are reflected in the **Activity Concentration levels (AC)** inside the measurement chamber (see Figures 1-2).

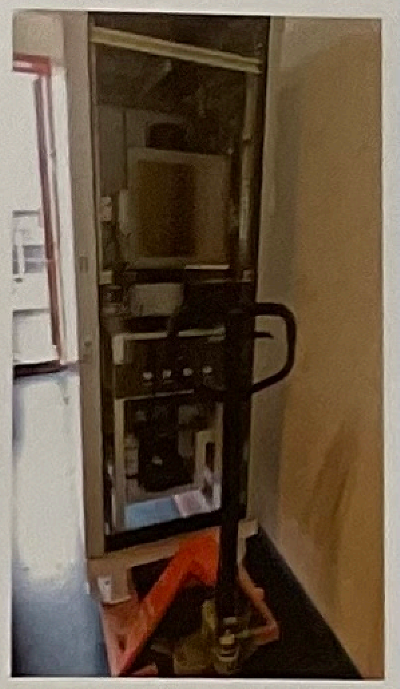
Typical MIPF TOTAL activity releases are within ~ 10^9 – ~ 10^{13} Bq/day concentration range (Saey WOSMIP 2016)

DESCRIPTION - UNITS	STAX REQUIREMENTS	EZEIZA MIPF STAX
DETECTION FRONT END cps - channels	The radiation detector for the STAX project should be a high purity germanium (HPGe) detector. The system should display typical HPGe energy resolution of ≤1.0 keV Full Width at Half Maximum (FWHM) at 122 keV and ≤2.0 keV at 1332 keV. It should be robust and use an aluminium window. The shielding thickness should be at least 5 cm of lead.	A high resolution High purity germanium detector (HPGe). Efficiency: 10% Ultra High Count Rate preamplifier(TRP) DSPEC50 Spectrum Analyser with MAESTRO Software • FHWM Required ≤1.0keV at 122keV • FHWM Required ≤2.0keV at 1332keV Custom designed lead shielding of 5 cm thick prevents from background interference.
CALIBRATION Bq- Kev	Detector calibration will be achieved by characterization of the detector to allow simulation based efficiency calibration. The detector can be calibrated using standard methods such as the use of gas or gas like standards, point sources, etc. The equipment should include a State of Health (SOH) monitoring of energy drift over time, this could be accomplished by the incorporation of an internal pulser at high energy or by self-calibration using signature peak e.g. 81 keV	Key Xenon isotopes monitored by STAX Project (133Xe, 135Xe, 133mXe, 131mXe). For experimental convenience, the detector is characterized and the efficiency of the measurement volume is calculated using "gas-like" calibration radioactive sources (namely, real geometry volume standard filled with a low density media simulating actual air volume inside the detection chamber and impregnated with calibration isotopes 133Ba and 152Eu, respectively)
MEASUREMENT CHAMBER Activity Concentration AC[Bq/m3]	The sample measurement chamber should be instrumented with pressure and temperature sensors. The exact design for the measurement chamber is not specified by the STAX project, however the sample flow though the chamber should be unrestricted and representative of the stack release The stack sample stream should be designed with the ability for pre-conditioning prior to the STAX detector system A robust pump must be installed after the mass flow controller that is sized accordingly to meet the necessary flow through the entire system and is able to operate more than one year without maintenance. In instances of extreme environmental conditions at the installation site, maintenance periods may vary	The sampling chamber is provided with: • A stainless steel measuring chamber, 1 dm³ volume • A low background shielding. • A flowmeter • Local Temperature and Pressure sensors (inside the measurement volume). • A Sampling pump: - Assures the gas sample renovation inside the volume. - Enables that the gas flow through the measurement chamber is representative of stack releases in the facility. - Continuous operation (since October 2021 up to date)
MEASUREMENT TIME MT[minutes]	Estimated effluent release every 15 minutes An ATS report will be sent from each facility at 24 hour increments and contain the estimated effluent release every 15 minutes as estimated from analyzing the corresponding spectrum.	Each measuring point is being recorded during 15 minutes, according to STAX Project requirements. Hence, 96 files are sent each day with those measurement information.
STACK AIR FLOW Flow [m3/h]	Data from the facility may include overall stack airflow, or any other relevant data stream provided by the facility.	The measured stack flow at CAE (CNEA) – MIP facility corresponds to that chimney connected to hot cells release. In this case the MIPF do have specific chimneys for specific releases corresponding to the hot cells and the general locals, respectively (see Fig.1). Other facilities– instead- do have a single (common) chimney for all gaseous releases (fig.2). This difference impacts on Activity Concentration (AC) levels at the plant stack.
DATA OUTPUT Emisión [Bq/h]	**Radioxenon Emission Data Output types** • 15 minutes emission values are reported once per day in a time series file in json format • System specific State-of-Health (SOH) data are transmitted every two hours • Optional, spectra (phd) messages in text file format (STAX1.0) are sent every 15 minutes • Alert messages are sent, triggered by user defined events Except for the time series format, the format of the data messages is similar to IMS2.0 format conventions.	Data output, (frequency, format, etc.) according to PNNL-26107 Document requirements









The STAX equipment shall be:

- Compact
- Structurally robust
- *Easy to translate/maneuversr*

MEASUREMENT TIME (MT)

Time elapsed for a single measurement.
Too long MT´s may hidden an emission peak.

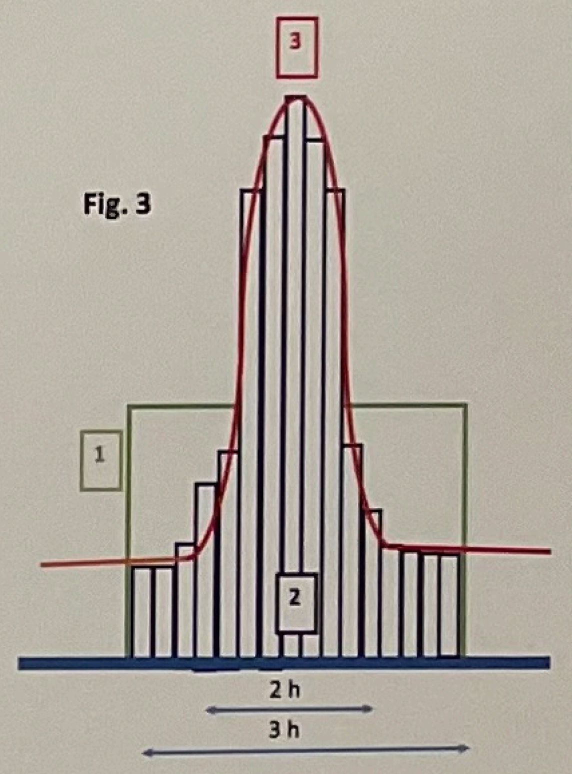
Example:

Peak length - 2hs.
MT 3hs (see 1 in the Figure 3)
STAX MT: 15min (see 2 in the Figure 3)
MT: 1 min (see 3 in the Figure 3)
A 15 minutes length MT enables to correctly identify one peak

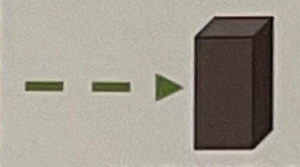
Radioxenon emissions are identifiable at CTBTO´s IMS monitoring stations at few hundred of kilometers away from a MIPF.

A relevant information to understand/characterize production runs, is to know in situ the magnitude and time of the radioxenon peaks.

Fig. 3

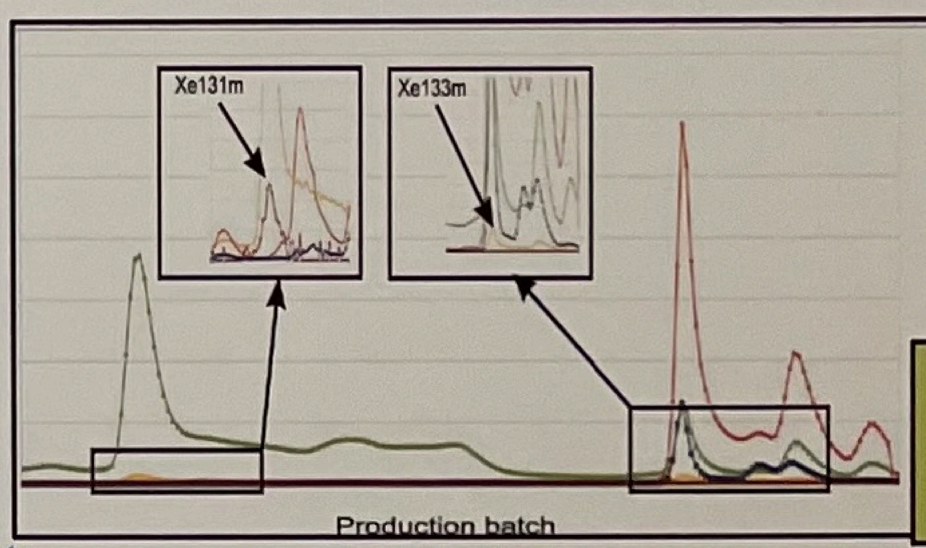


MIPF



STAX EXPERIMENTAL DATABASE

An ATS report will be sent from each facility at 24 hour increments.



Activity Concentration detection capabilities

Xe^{133}	bq/m³	1,60E+4 up to 2,61E+11
Xe^{135}	bq/m³	4,05E+3 up to 1,00E+11
Xe^{133m}	bq/m³	3,95E+4 up to 7,36E+11
Xe^{131m}	bq/m³	1,90E+5 up to 3,13E+12

References

- **Doll et al.**, "STAX (Source Term Analysis of Xenon) Experiment Project Work Plan–Year 1",October2016.
- **PNNL-26107** Stack Release Data Requirements for the STAX Experiment ,October 2016
- **PNNL-27352** Hardware and Software Guidelines for the STAX Project April 2018 JI Friese
- **INVAP STAX monitor performance at Medical Isotope Production Facility, CAE-CNEA, Argentina** Federico Fernández Baldis, Mauro Núñez, Román Pino, Andrés Zapata, Eduardo Carranza, Mariana Di Tada, Eduardo Nassif, Ricardo Sagarzazu, Horacio Boccoli
- **INVAP Document 0909-STAX-3DSIN-002-A "Radioactive Noble Gas Monitoring Specifications & Requirements for equipment Assembly and Installation" (prepared by INVAP for PNNL, Oct, 2020).**
- **INVAP Document : 0909-STAX--3 DEIN-019-B "Radioactive Noble Gas Monitoring System INVAP Monitor Operational Manual"** (prepared by INVAP for PNNL Jul, 2021)
- **Use of STAX Data in Global-Scale Simulation of ^{133}Xe Atmospheric Background.** Author: Sylvia Generoso, Pascal Achim, Mireille Morin, Philippe Gross, Guilhem Douysset

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